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(54) Title: **ANTIBODIES AGAINST THE ADVANCED GLYCOSYLATION END-PRODUCT RECEPTOR AND USES THEREOF**

(57) Abstract

It is a general object of the present invention to provide compositions that specifically interact with advanced glycosylation end products (AGEs) or their receptors. Such compositions may be used in a variety of applications including therapeutic applications, e.g., as blocking agents to inhibit or otherwise reduce the AGE/RAGE interaction, screening applications, e.g., as models of the AGE/RAGE interaction, and diagnostic applications, e.g., to identify abnormal levels of AGE or RAGE in a given system.

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ANTIBODIES AGAINST THE ADVANCED GLYCOSYLATION END-PRODUCT RECEPTOR AND USES THEREOF

BACKGROUND OF THE INVENTION

- 5 Advanced glycosylation end-products of proteins (AGEs) have been implicated in a variety of disorders including complications associated with diabetes and normal aging. AGEs are nonenzymatically glycosylated proteins which have been shown to accumulate in vascular tissue in aging and at an accelerated rate in individuals with diabetes. Particularly, AGEs result from the non-enzymatic, but
- 10 concentration dependant interaction of glucose and other reducing sugars with amino groups on proteins to form glycosylated proteins termed Amadori adducts. Over time, these Amadori adducts undergo additional rearrangements, dehydrations and cross-linking with other proteins to accumulate as a family of complex structures referred to as AGEs.
- 15 AGEs have been shown to bind specifically in a saturable and reversible manner to cell surface receptors, including receptors expressed on the surface of endothelial cells and particularly those of the microvasculature, monocytes/macrophages, smooth muscle cells, mesengial cells and neurons.
- 20 Following binding to cell surface receptors, AGEs are taken up in vesicles and either degraded intracellularly or transported through the cells and deposited in the sub-endothelial matrix, where they accumulate. Esposito et al., J. Exp. Med. 170:1387-1407 (1989). In addition, chemotactic signals for monocytes, but not other white cells are released. These monocytes then adhere and diapedese through the endothelial cell layer. Kirstein et al., Proc. Nat'l Acad. Sci. USA 87:9010-9014 (1990).
- 25 AGEs also have been shown to cause proliferation of endothelial cells, which become more permeable and more thrombogenic, i.e., thrombomodulin is downregulated while tissue factor is upregulated. Esposito et al., J. Exp. Med. 170:1387-1407 (1989).
- 30 Monocytes\macrophages can also take up AGEs through their receptors which are distinct from the acetyl-LDL receptors, but which may be related to the receptors for aldehyde-modified proteins. Takata et al., J. Biol. Chem. 263:14819-14825 (1988), Takata et al., Biochim. Biophys. Acta 986:18-26 (1989), Radoff et al., Diabetes 39:1510-1518 (1990). Binding of AGEs to monocytes *in vitro* leads to the induction of cytokines, TNF and IL-1, which then stimulate the release of a number of other growth factors responsible for cell proliferation, migration and matrix synthesis. Vlassara et al., Science 240:1546-1548 (1988). Increased synthesis of matrix proteins in response to AGEs binding has also been

demonstrated for mesangial cells. Skolnick et al., J. Exp. Med. 174:931-939 (1991), Doi et al., Proc. Nat'l Acad. Sci. USA 89:2873-2877 (1992).

Evidence has indicated that the binding of AGEs to their receptors either directly or indirectly induces inflammatory responses in vessel walls, which 5 can trigger or aggravate the pathogenesis of diabetic macro- or microangiopathy. For an overview of the effects of AGEs, see, e.g., Vlassara et al., Laboratory Invest. 70(2):138-151 (1994). Stern et al., J. Biol. Chem. 267:14998-15004 (1992) has reported similarities between RAGE proteins and the Ig superfamily molecules.

Because of the effects AGEs may have in the pathogenesis of a 10 number of disorders, it would generally be desirable to provide compositions and methods to block or otherwise inhibit these effects, and particularly the interaction between AGEs and their cell surface receptors. The present invention meets these and a variety of other needs.

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SUMMARY OF THE INVENTION

It is a general object of the present invention to provide novel 20 polypeptides and antibodies, as well as methods of using these polypeptides and antibodies in screening, diagnostic and therapeutic applications.

In a first aspect, the present invention provides isolated antibodies that are specifically immunoreactive with a soluble human RAGE polypeptide. In particular, the antibodies of the invention will be specifically immunoreactive with a polypeptide having an amino acid sequence substantially homologous to the amino 25 acid sequence shown in Figure 1 (Seq ID NOS: 2 and 4), or immunologically active fragments thereof. The present invention also provides pharmaceutical compositions which include these antibodies.

The antibodies of the present invention may also be used in therapeutic applications. For example, in a further aspect, the present invention 30 provides methods of treating a patient for symptoms of a disorder which are caused by an interaction between an AGE and its receptor. The methods comprise administering an effective amount of an antibody that is specifically immunoreactive with a soluble human RAGE polypeptide to the patient.

In an additional aspect, the antibodies of the present invention may be 35 used as affinity probes. For example in an additional aspect, the antibodies of the invention may be used in methods for detecting a human RAGE polypeptide in a sample. The methods comprise contacting the sample with an isolated antibody that is specifically immunoreactive with a soluble human RAGE polypeptide, and

determining whether the antibody specifically immunoreacts with a component of the sample.

- In a related aspect, the invention provides methods of purifying human RAGE polypeptides from a mixture of proteins. For these methods, an antibody that is specifically immunoreactive with a soluble human RAGE polypeptide is immobilized on a solid support. The solid support is contacted with the mixture of proteins under conditions which will permit specific immunoreaction between the antibody and the human RAGE polypeptide. The solid support is washed to remove nonspecifically bound proteins and the RAGE polypeptide is eluted from the solid support in substantially pure form.

Further, the present invention provides the use of an effective amount of an antibody that is specifically immunoreactive with a soluble human RAGE polypeptide for the production of a pharmaceutical compound or composition for the treatment of a patient for symptoms of a disorder, wherein said symptoms are caused by an interaction between an AGE and its receptor. Especially, said patients are diabetic patients, and said symptom is increased vascular permeability. Especially, said disorder is Diabetes Mellitus and said symptom is selected from the group consisting of diabetic microvasculopathy, diabetic macrovasculopathy and occlusive vascular disorder. Especially, said symptoms are selected from the group consisting of neuropathy, nephropathy, retinopathy and atherosclerosis. Especially, said symptom is hemodialysis-associated amyloidosis.

BRIEF DESCRIPTION OF THE DRAWINGS

- Figures 1A and 1B show the nucleic acid sequence and deduced
5 amino acid sequence of a soluble human RAGE polypeptide (Seq ID NOS: 1-4).
Figure 1A shows the DNA and amino acid sequence of soluble human RAGE which
includes an expressed pre-sequence (Seq ID NOS: 1-2), whereas Figure 1B shows
the sequences for mature soluble human RAGE (Seq ID NOS: 3-4). Standard
three-letter abbreviations are used to denote the individual amino acids.
10 Figures 2A and 2B show binding of an AGE-BSA protein to indirectly
immobilized RAGE polypeptide. Figure 2A shows total binding of labeled AGE-BSA
to RAGE immobilized indirectly upon a solid support through a FLAG
peptide/antiFLAG antibody interaction which mimics the cell surface presentation of
RAGE (squares). Also shown is nonspecific binding (diamonds)(labeled AGE-BSA
15 binding in the presence of excess unlabeled AGE-BSA). Figure 2B shows
corrected, specific binding of AGE-BSA to RAGE polypeptide that is indirectly
coupled to the solid support.

- Figure 3 shows a dose response curve for RAGE/AGE binding in the
presence of increasing concentrations of free RAGE
20 Figure 4A is a bar graph showing levels of antibody binding to human
soluble RAGE using an EIA antibody capture assay. Binding is compared between
intact soluble RAGE (dark bars) and RAGE/DCC chimeric protein (in which the first
Ig-like domain of RAGE is replaced with the first Ig-like domain of DCC, a member
25 of the Ig superfamily. Four antibodies (#5, 9, 14 and 19) recognized both the intact
soluble RAGE and the chimeric protein. Figures 4B and 4C show antibody binding
to peptide fragments of soluble human RAGE, designated peptide 1
(CKGAPKKPPQ) (Seq ID NO: 5), fragment 2 (WKLNTGRTEAC) (Seq ID NO: 6)
and fragment 8 (GPQDQGTYSC) (Seq ID NO: 7).

- Figure 5 shows a Western Blot hybridization of anti-RAGE MAb
30 SW1E8 (ATCC Accession No. HB-12166). Lanes 1-3 represent rat, mouse and
human RAGE expressed in Baculovirus, respectively. Lanes were loaded with 5 µl
of conditioned media. Monomeric RAGE is apparent as a doublet at approximately
41 Kd.

- Figures 6A and 6B show results of a direct antigen capture EIA.
35 Figure 6A shows a capture assay employing MAb RBF9D9 (ATCC Accession No.
HB-12165) as the RAGE capture antibody and MAb SW10C1 (ATCC Accession No.
HB-12164) as the RAGE detection antibody, which recognizes human, but not
murine RAGE. Figure 6B shows a capture assay employing MAb RBF9D9 (ATCC
Accession No. HB-12165) as the RAGE capture antibody and MAb SW1E8 (ATCC

Accession No. HB-12166) as the detection antibody, which recognizes both human and murine RAGE.

Figure 7 shows the results of flow cytometry of CHO parental cells and CHO cells transfected with full length human RAGE, using anti-RAGE MAb

- 5 SW10C1 (ATCC Accession No. HB-12164). Sixty nine of the original 72 MAb panel demonstrated similar reactivity with cell surface RAGE.

Figures 8A and 8B show results of flow cytometry of CHO parental and CHO-RAGE transfectants incubated with lactoferrin and immunostained with anti-RAGE/phycoerythrin (Figure 8A) and anti-lactoferrin/FITC (Figure 8B).

- 10 Figures 9A and 9B show the in vitro permeability of confluent BEAC layers by albumin and inulin. Permeability is shown following incubation with medium (control, white bar), normal RBCs (black bar) and diabetic RBCs (hatched bars). Reversal of diabetic RBC associated permeability is demonstrated following pretreatment with soluble recombinant RAGE (sRAGE) but not control protein
15 (sVCAM).

Figure 10 shows plasma pharmacokinetics of ¹²⁵I-human recombinant RAGE after an intravenous infusion into rat.

- Figures 11A and 11B show comparisons of efficiency of recombinant soluble human RAGE and recombinant rat-VCAM in reversing permeability induced
20 by diabetic RBC incubation in various tissues of normal (Figure 11A) and diabetic rats (Figure 11B).

Figure 12 shows a schematic illustration of the blood-tissue albumin transport tracer uptake method. Also shown are the calculations used to obtain albumin clearance values.

- 25 Figures 13A, 13B and 13C show albumin clearance from various tissues in control rats (white bar), diabetic rats (left black bar), diabetic rats with soluble RAGE pretreatment (middle black bar) and diabetic rats with soluble VCAM-1 pretreatment (right black bar) in early (Figure 13A), mid (Figure 13B) and late (Figure 13C) phases of STZ-induced diabetes.

- 30 Figures 14A, 14B and 14C show extravascular water levels from various tissues in control rats (white bar), diabetic rats (left black bar), diabetic rats with soluble RAGE pretreatment (middle black bar) and diabetic rats with soluble VCAM-1 pretreatment (right black bar) in early (Figure 14A), mid (Figure 14B) and late (Figure 14C) phases of diabetes.

- 35 Figures 15A and 15B show adhesion of RAGE pretreated and control RBCs to single vessels.

DETAILED DESCRIPTION OF THE INVENTION

I. General

The major pathological conditions in which AGEs have been implicated as exerting adverse effects include Diabetes Mellitus in which hyperglycemia exists, as well as a number of aging related disorders. AGE formation in biological systems is dependant upon blood-glucose concentration and time of incubation. Without being bound to a particular theory, it is believed that this time/concentration dependency accounts for the adverse effects in hyperglycemic diabetics as well as the elderly. Similarly, proteins which themselves have a longer half-life, are more prone to undergo glycosylation to form AGEs. In diabetic patients, a high level of plasma glucose leads to glycosylation of various plasma proteins, including hemoglobin and LDL (low-density lipoprotein) as well as enzymes and matrix proteins. The accumulation of these AGEs induce a number of permanent abnormalities in the extracellular matrix component function, and stimulate cytokines and reactive oxygen species production through AGE-specific receptors. Inhibition of AGE formation in long term diabetic animals has also been shown to prevent or reduce the severity of a number of elements of the pathology of diabetes, including retinopathy, nephropathy, neuropathy and arterial abnormalities.

Brownlee, Ann. Rev. Med. 46:223-234 (1995), Zimmerman et al., Proc. Nat'l Acad. Sci. USA 92:3744-3748 (1995).

A number of proteins associated with Alzheimer's disease, e.g., amyloid, tau, the major components of neurofibrillary tangles and senile plaques, are found to be similarly modified. Smith et al., Nature 374:316 (1995), Smith et al., Proc. Nat'l Acad. Sci. USA, 91:5710-5714 (1994), Vitek et al., Proc. Nat'l Acad. Sci. USA, 91:4766-4770 (1994). Additionally, in hemodialysis-associated amyloidosis, β_2 -microglobulin, a major component of amyloid fibrils, is modified by glycosylation. Miyata et al., J. Clin. Invest. 93:521-528 (1994). In atherosclerosis, in both the diabetic and non-diabetic populations, LDL, Lp(a)(lipoprotein little a) and immunoglobulin that are trapped and/or cross-linked to the matrix within the vessel wall are modified by glycosylation. The presence of AGEs produces a local, chronic inflammation, through a number of mechanisms including receptor-mediated pathway and oxidant stress. As a result, it is apparent that AGE modification causes and/or aggravates these various pathological conditions.

Because of these effects of AGEs in the pathogenesis of various disorders, it is a general object of the present invention to provide compositions that specifically interact with advanced glycosylation end products (AGEs) or their receptors. Such compositions may be used in a variety of applications including therapeutic applications, e.g., as blocking agents to inhibit or otherwise reduce the AGE/RAGE interaction, screening applications, e.g., as models of the AGE/RAGE

interaction, and diagnostic applications, e.g., to identify abnormal levels of AGE or RAGE in a given system.

In preferred aspects, the present invention provides compositions comprising soluble RAGE polypeptides, antibodies that are specifically

- 5 immunoreactive with soluble RAGE polypeptides, and methods of using these compositions in screening, therapeutic and diagnostic applications.

II. Polypeptides

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In a first aspect, the present invention provides substantially pure or isolated polypeptides that are related to and/or derived from human RAGE polypeptides. The terms "substantially pure" or "isolated", when referring to proteins and polypeptides, denote those polypeptides that are separated from proteins or other contaminants with which they are naturally associated. A protein or polypeptide is considered substantially pure when that protein makes up greater than about 50% of the total protein content of the composition containing that protein, and typically, greater than about 60% of the total protein content. More typically, a substantially pure or isolated protein or polypeptide will make up from about 75 to about 90% of the total protein. Preferably, the protein will make up greater than about 90%, and more preferably, greater than about 95% of the total protein in the composition.

In particular aspects, the isolated polypeptides of the present invention are related to and/or derived from soluble human RAGE polypeptides. As used herein, the term "soluble" generally refers to RAGE derived polypeptides that lack a transmembrane region that is associated with full length RAGE polypeptides. Thus, soluble RAGE polypeptides generally comprise fragments of the extracellular domain of RAGE. In certain embodiments, the soluble peptides of the invention will comprise one or more of the Ig-like domains of the extracellular region of RAGE.

30 As used herein, "AGE" refers to an advanced glycosylation end-product. Typically, such AGEs may be full length proteins, polypeptides or aggregations of proteins and/or polypeptides.

The polypeptides of the invention also may be characterized by their ability to either mimic or inhibit the interaction between AGEs and their receptors, e.g., RAGE. Those polypeptides which are mimetic of either AGE or its receptors in the AGE/receptor interaction are termed AGE or AGE receptor "mimics".

In particularly preferred aspects, the polypeptides of the invention will have an amino acid sequence that is related to or derived from the amino acid sequence of soluble human RAGE as shown in Figures 1A and 1B (Seq ID NOS: 2

- and 4). Although described in terms of the amino acid sequence shown in Figure 1A and 1B (Seq ID NOS: 2 and 4), it will be readily understood that the polypeptides of the present invention include those peptides having the listed amino acid sequence or biologically active fragments thereof, as well as those polypeptides 5 having amino acid sequences that are substantially homologous to the listed sequence.

The terms "substantially homologous" when referring to polypeptides, refer comparatively to two amino acid sequences which, when optimally aligned, are at least about 75% homologous, preferably at least about 85% homologous more 10 preferably at least about 90% homologous, and still more preferably at least about 95% homologous. Optimal alignment of sequences for aligning a comparison window may be conducted by the local homology algorithm of Smith and Waterman (1981) Adv. Appl. Math. 2:482, by the homology alignment algorithm of Needleman and Wunsch (1970) J. Mol. Biol. 48:443, by the search for similarity method of 15 Pearson and Lipman (1988) Proc. Natl. Acad. Sci. (USA) 85:2444, or by computerized implementations of these algorithms (GAP, BESTFIT, FASTA, and TFASTA in the Wisconsin Genetics Software Package Release 7.0, Genetics Computer Group, 575 Science Dr., Madison, WI).

The term "biologically active fragment" as used herein, refers to 20 portions of the soluble RAGE polypeptides, which possess a particular biological activity. For example, such biological activity may include the ability to bind a particular protein, substrate or ligand, e.g., AGE, to have antibodies generated against it, to block or otherwise inhibit an interaction between two proteins, e.g., a receptor and its ligand, such as AGE and RAGE, between an enzyme and its 25 substrate, between an epitope and an antibody, or such fragments may include a particular catalytic activity. With regard to the polypeptides of the present invention, particularly preferred polypeptides or biologically active fragments include, e.g., polypeptides that possess one or more of the biological activities described above, such as the ability to specifically interact with AGEs, the ability to block, reduce, or 30 otherwise inhibit the interaction between AGEs and RAGE, and the ability to elicit antibodies that are specifically immunoreactive with AGEs or RAGE. Those fragments that are specifically recognized and bound by antibodies raised against the polypeptides of the invention are also included in the definition of biologically active fragments. Such fragments are also referred to herein as "immunologically 35 active fragments." Examples of immunologically active fragments include those fragments comprising the amino acid sequences specifically described below, and particularly those selected from the group consisting of: WKLNTGRTEA (Seq ID NO: 8), CEVPAQPSPI (Seq ID NO: 9), CRAMNQNGKETKSN (Seq ID NO: 10), GPQDQGTYSC (Seq ID NO: 11), AQNITARIGEPLVLK (Seq ID NO: 12),

CKGAPKKPPQ (Seq ID NO: 13), EQTRRH PET (Seq ID NO: 14), RGGDPRPTFSC (Seq ID NO: 15), SPGLPRH RAL (Seq ID NO: 16), and SSHGPQESRA (Seq ID NO: 17).

- As described previously, the polypeptides of the invention may further include modifications to the N- or C-termini, i.e., acetylation, amidation, or inclusion of additional amino acids to assist in conjugation with other proteins or other compounds, e.g., polypeptides having the following sequences: WKLNTGRTEAC (Seq ID NO: 6); AQNITARIGEPLVLKC (Seq ID NO: 18); CEQTRRH PET (Seq ID NO: 19); CSPGLPRH RAL (Seq ID NO: 20); and SSHGPQESRAC (Seq ID NO: 21).

The polypeptides of the invention may also be characterized by their ability to block the interaction between two proteins, e.g. AGE and RAGE, RAGE and anti-RAGE Abs, or AGE and anti-AGE Abs. In particular, included in the polypeptides of the present invention are peptides derived from human RAGE proteins that are capable of blocking or otherwise inhibiting the interaction between human RAGE and its ligands and particularly, AGEs. Examples of such polypeptides include fragments of human RAGE which encompass the AGE binding regions of the RAGE protein as well as AGE-binding proteins that sterically interfere with RAGE/AGE binding.

- As referenced above, the polypeptides of the present invention may also be characterized by their ability to bind antibodies raised against proteins or polypeptides having the amino acid sequences of soluble human RAGE, as shown in Figure 1A and 1B (Seq ID NOS: 2 and 4), or fragments thereof. These antibodies generally recognize polypeptides that are homologous to at least portions of human RAGE proteins or their immunologically active fragments. A variety of immunoassay formats may be used to select antibodies specifically immunoreactive with a particular protein or domain. For example, solid-phase ELISA immunoassays are routinely used to select monoclonal antibodies specifically immunoreactive with a protein. See Harlow and Lane (1988) *Antibodies, A Laboratory Manual*, Cold Spring Harbor Publications, New York, for a description of immunoassay formats and conditions that can be used to determine specific immunoreactivity. Antibodies to the polypeptides of the present invention are discussed in greater detail, below.

Generally, the biologically active fragments of the polypeptides described herein may include any subsequence of the above described RAGE polypeptide. Typically, however, such biologically active fragments will range in size from about 10 amino acids in length to about 320 amino acids in length. More typically, the biologically active fragments will be from about 10, 11, 12, 13, 14, 15 or 16 amino acids in length to about 50 amino acids in length.

- Examples of particularly preferred biologically active fragments of soluble human RAGE include peptides comprising an amino acid sequence selected from the group consisting of WKLNTGRTEA (Seq ID NO: 8), CEVPAQPSPKI (Seq ID NO: 9), CRAMNQNGKETKSN (Seq ID NO: 10),
5 GPQDQGTYSC (Seq ID NO: 11), AQNITARIGEPLVLK (Seq ID NO: 12), CKGAPKKPPQ (Seq ID NO: 13), EQTRRHPE (Seq ID NO: 14), RGGDPRPTFSC (Seq ID NO: 15), SPGLPRHRAL (Seq ID NO: 16), and SSHGPQESRA (Seq ID NO: 17).

The polypeptides of the present invention may generally be prepared
10 using recombinant or synthetic methods that are well known in the art. Recombinant techniques are generally described in Sambrook, et al., Molecular Cloning: A Laboratory Manual, (2nd ed.) Vols. 1-3, Cold Spring Harbor Laboratory, (1989). The term recombinant is also intended to encompass the recombinant expression of heterologous genetic material which is introduced into a host cell or
15 transfected through viral transfection techniques. Techniques for the synthesis of polypeptides are generally described in Merrifield, J. Amer. Chem. Soc. 85:2149-2456 (1963), Atherton, et al., Solid Phase Peptide Synthesis: A Practical Approach, IRL Press (1989), and Merrifield, Science 232:341-347 (1986). In preferred aspects, the polypeptides of the present invention may be expressed by a suitable
20 host cell that has been transfected with a nucleic acid of the invention, as described in greater detail below.

Biologically active fragments of the above described polypeptides may generally be identified and prepared using methods well known in the art. For example, selective proteolytic digestion, recombinant deletional methods or *de novo*
25 peptide synthesis methods may be employed to identify portions of the above described peptides that possess the desired biological activity, e.g., AGE binding, presence of immunological determinants, and the like. See, e.g., Sambrook, et al.

Isolation and purification of the polypeptides of the present invention can be carried out by methods that are generally well known in the art. For
30 example, the polypeptides may be purified using readily available chromatographic methods, e.g., ion exchange, hydrophobic interaction, HPLC or affinity chromatography, to achieve the desired purity. Affinity chromatography may be particularly attractive in allowing an individual to take advantage of the specific biological activity of the desired peptide, e.g., AGE binding, presence of antigenic determinants or the like. For example, antibodies raised against human RAGE polypeptides or its immunologically active fragments, may be coupled to a suitable solid support and contacted with a mixture of proteins containing the polypeptides of the invention under conditions conducive to the association of these polypeptides with the antibody. Once bound to the immobilized antibody, the solid support is

washed to remove unbound material and/or nonspecifically bound proteins. The desired polypeptides may then be eluted from the solid support in substantially pure form by, e.g., a change in salt, pH or buffer concentration. Alternatively, the affinity of the soluble RAGE polypeptides for AGEs may be used advantageously to purify 5 these peptides. In particular, AGEs, e.g. BSA-AGE, may be immobilized as described above, for use as affinity probes in the purification of the soluble RAGE polypeptides.

In addition to those polypeptides and fragments described above, the present invention also provides fusion proteins which contain these polypeptides or 10 fragments. Fusion proteins may be useful in providing for enhanced expression of the RAGE polypeptide constructs, or in producing RAGE polypeptides having other desirable properties, e.g., labeling groups, e.g., enzymatic reporter groups, binding groups, antibody epitopes, etc.

The term "fusion protein" as used herein, generally refers to a 15 composite protein, i.e., a single contiguous amino acid sequence, made up of two distinct, heterologous polypeptides which are not normally fused together in a single amino acid sequence. Thus, a fusion protein may include a single amino acid sequence that contains two entirely distinct amino acid sequences or two similar or identical polypeptide sequences, provided that these sequences are not normally 20 found together in a single amino acid sequence. Fusion proteins may generally be prepared using either recombinant nucleic acid methods, i.e., as a result of transcription and translation of a gene fusion, which fusion comprises a segment encoding a polypeptide of the invention and a segment encoding a heterologous protein, or by chemical synthesis methods well known in the art.

25 Also included within the present invention are amino acid variants of the above described polypeptides. These variants may include insertions, deletions and substitutions with other amino acids. For example, in some aspects, conservative amino acid substitutions may be made, i.e., substitution of selected amino acids with different amino acids having similar structural characteristics, e.g., 30 net charge, hydrophobicity and the like. Examples of such conservative substitutions include, e.g., Ala:Val:Leu:Ile:Met, Asp:Glu, Lys:Arg, Asn:Gln, Phe:Tyr and Ser:Thr Glycosylation modifications, either changed, increased amounts or decreased amounts, as well as other sequence modifications are also included within the polypeptides of the invention.

35 Systematic substitution of one or more amino acids of a consensus sequence with a D-amino acid of the same type (e.g., D-lysine in place of L-lysine) may also be used to generate more stable peptides. In addition, constrained peptides comprising a consensus sequence or a substantially identical consensus sequence variation may be generated by methods known in the art (Rizo and

Gierasch (1992) Ann. Rev. Biochem. 61:387; for example, by adding internal cysteine residues capable of forming intramolecular disulfide bridges which cyclize the peptide. Similarly, modification of the amino or carboxy terminals may also be used to confer stabilizing properties upon the polypeptides of the invention, e.g.,

- 5 amidation of the carboxy-terminus or acylation of the amino-terminus. Substitution of amino acids involved in catalytic activity can be used to generate dominant negative inhibitors of signaling pathways.

Furthermore, although primarily described in terms of "proteins" or "polypeptides" one of skill in the art, upon reading the instant specification, will appreciate that these terms also include structural analogs and derivatives of the above-described polypeptides, e.g., polypeptides having conservative amino acid insertions, deletions or substitutions, peptidomimetics, and the like. For example, in addition to the above described polypeptides which consist only of naturally-occurring amino acids, peptidomimetics of the polypeptides of the present invention are also provided. Peptide analogs are commonly used in the pharmaceutical industry as non-peptide drugs with properties analogous to those of the template peptide. These types of non-peptide compounds are termed "peptide mimetics" or "peptidomimetics" (Fauchere, J. (1986) Adv. Drug Res. 15:29; Veber and Freidinger (1985) TINS p.392; and Evans et al. (1987) J. Med. Chem. 30:1229, and 10 are usually developed with the aid of computerized molecular modeling. Peptide mimetics that are structurally similar to therapeutically useful peptides may be used to produce an equivalent therapeutic effect. Generally, peptidomimetics are structurally similar to a paradigm polypeptide (*i.e.*, a polypeptide that has a biological or pharmacological activity), such as naturally-occurring receptor 15 polypeptides, but have one or more peptide linkages optionally replaced by a linkage selected from the group consisting of: -CH₂NH-, -CH₂S-, -CH₂-CH₂-, -CH=CH- (*cis* and *trans*), -COCH₂-, -CH(OH)CH₂-, and -CH₂SO-, by methods known in the art and further described in the following references: Spatola, A.F. in 20 Chemistry and Biochemistry of Amino Acids, Peptides, and Proteins, B. Weinstein, eds., Marcel Dekker, New York, p. 267 (1983); Spatola, A.F., Vega Data (March 1983), Vol. 1, Issue 3, "Peptide Backbone Modifications" (general review); Morley, J.S., Trends Pharm. Sci. (1980) pp. 463-468 (general review); Hudson, D. et al., Int. J. Pept. Prot. Res. (1979) 14:177-185 (-CH₂NH-, -CH₂CH₂-); Spatola, A.F. et al., Life Sci (1986) 38:1243-1249 (-CH₂S-); Hann, M.M., J. Chem. Soc. Perkin Trans. I 25 (1982) 307-314 (-CH=CH-, *cis* and *trans*); Almquist, R.G. et al., J. Med. Chem. (1980) 23:1392-1398 (-COCH₂-); Jennings-White, C. et al., Tetrahedron Lett. (1982) 23:2533 (-COCH₂-); Szelke, M. et al., European Appln. EP 45665 (1982) CA: 30 97:39405 (1982) (-CH(OH)CH₂-); Holladay, M.W. et al., Tetrahedron Lett. (1983) 24:4401-4404 (-C(OH)CH₂-); and Hruby, V.J., Life Sci. (1982) 31:189-199 (-CH₂S-).

Peptide mimetics may have significant advantages over polypeptide embodiments, including, for example: more economical production; greater chemical stability; enhanced pharmacological properties (half-life, absorption, potency, efficacy, etc.); altered specificity (e.g., a broad-spectrum of biological activities); reduced antigenicity; and others.

For many applications, it will also be desirable to provide the polypeptides of the invention as labeled entities, i.e., covalently attached or linked to a detectable group, to facilitate identification, detection and quantification of the polypeptide in a given circumstance. These detectable groups may comprise a detectable protein group, e.g., an assayable enzyme or antibody epitope as described above in the discussion of fusion proteins. Alternatively, the detectable group may be selected from a variety of other detectable groups or labels, such as radiolabels (e.g., ¹²⁵I, ³²P or ³⁵S) or a chemiluminescent or fluorescent group. Similarly, the detectable group may be a substrate, cofactor, inhibitor or affinity ligand. Labeling of peptidomimetics usually involves covalent attachment of one or more labels, directly or through a spacer (e.g., an amide group), to non-interfering position(s) on the peptidomimetic that are predicted by quantitative structure-activity data and/or molecular modeling. Such non-interfering positions generally are positions that do not form direct contacts with the molecules to which the peptidomimetic binds (e.g., AGE) to produce the therapeutic effect. Derivitization (e.g., labeling) of peptidomimetics should not substantially interfere with the desired biological or pharmacological activity of the peptidomimetic. Generally, peptidomimetics of peptides of the invention bind to their ligands (e.g., AGEs) with high affinity and/or possess detectable biological activity (i.e., are agonistic or antagonistic to AGE/RAGE interaction and phenotypic changes brought about by those interactions).

III. Antibodies to RAGE

In an additional aspect, the present invention provides antibodies that are specifically immunoreactive with human RAGE and more particularly, the soluble human RAGE polypeptides of the invention. The phrase "specifically immunoreactive," when referring to the interaction between an antibody of the invention and a particular protein, refers to an antibody that specifically recognizes and binds with relatively high affinity to the protein of interest, e.g., RAGE, such that this binding is determinative of the presence of the protein in a heterogeneous population of proteins and other biologics. Thus, under designated immunoassay conditions, the specified antibodies bind to a particular protein and do not bind in a significant amount to other proteins present in the sample. A variety of

- immunoassay formats may be used to select antibodies specifically immunoreactive with a particular protein. For example, solid-phase ELISA immunoassays are routinely used to select monoclonal antibodies specifically immunoreactive with a protein. See, Harlow and Lane (1988) *Antibodies, A Laboratory Manual*, Cold Spring Harbor Publications, New York, for a description of immunoassay formats and conditions that can be used to determine specific immunoreactivity.

For production of polyclonal antibodies, an appropriate target immune system is selected, typically a mouse or rabbit, but also including goats, sheep, cows, guinea pigs, monkeys and rats. The substantially purified antigen is presented to the immune system in a fashion determined by methods appropriate for the animal. These and other parameters are well known to immunologists. Typically, injections are given in the footpads, intramuscularly, intradermally or intraperitoneally. The immunoglobulins produced by the host can be precipitated, isolated and purified by routine methods, including affinity purification.

For monoclonal antibodies, appropriate animals will be selected and the desired immunization protocol followed. After the appropriate period of time, the spleens of these animals are excised and individual spleen cells are fused, typically, to immortalized myeloma cells under appropriate selection conditions. Thereafter, the cells are clonally separated and the supernatants of each clone are tested for the production of an appropriate antibody specific for the desired region of the antigen. Techniques for producing antibodies are well known in the art. See, e.g., Goding et al., *Monoclonal Antibodies: Principles and Practice* (2d ed.) Acad. Press, N.Y., and Harlow and Lane, *Antibodies: A Laboratory Manual*, Cold Spring Harbor Laboratory, New York (1988). Other suitable techniques involve the *in vitro* exposure of lymphocytes to the antigenic polypeptides or alternatively, to selection of libraries of antibodies in phage or similar vectors. Huse et al., Generation of Large Combinatorial Library of the Immunoglobulin Repertoire in Phage Lambda, *Science* 246:1275-1281 (1989). Monoclonal antibodies with affinities of 10^8 liters/mole, preferably 10^9 to 10^{10} or stronger, will be produced by these methods.

The antibodies generated can be used for a number of purposes, e.g., as probes in immunoassays, for inhibiting interaction between AGEs and their receptors, in diagnostic or therapeutic applications. These applications are discussed in greater detail, below. Where the antibodies are used to block the interaction between AGEs and their receptors, the antibody will generally be referred to as a "blocking antibody."

The antibodies of the present invention can be used with or without modification. Frequently, the antibodies will be labeled by joining, either covalently or non-covalently, a substance which provides for a detectable signal. Such labels include those that are well known in the art, such as the labels described previously

- for the polypeptides of the invention, e.g., radioactive, fluorescent or bioactive labels. As labeled binding entities, the antibodies of the invention may be particularly useful in, e.g., diagnostic applications, for identifying abnormal levels of RAGE in human tissue or blood samples which abnormal levels may be indicative 5 of the existence of or enhanced potential for those disorders associated with excessive RAGE/AGE interaction, as described herein.

In alternative aspects, the antibodies of the present invention may be used as affinity ligands in the quantitation and/or purification of the RAGE polypeptides from a mixture of proteins. These antibody affinity purification 10 methods are well known in the art, and typically involve the immobilization of a particular antibody, e.g., an antibody to soluble human RAGE, upon a solid support. Solid supports for use in affinity chromatography are generally commercially available from, e.g., Sigma Chemical Co. (St Louis MO) and Pharmacia (Uppsala, Sweden).

15 Additionally, the antibodies of the invention may be chimeric, human-like or humanized, in order to reduce their potential antigenicity, without reducing their affinity for their target. Chimeric, human-like and humanized antibodies have generally been described in the art. Generally, such chimeric, human-like or humanized antibodies comprise hypervariable regions, e.g., complementarity 20 determining regions (CDRs) from a mammalian animal, i.e., a mouse, and a human framework region. See, e.g., Queen, et al., Proc. Nat'l Acad. Sci. USA 86:10029 (1989), Verhoeven, et al., Science 239:1534-1536 (1988). By incorporating as little foreign sequence as possible in the hybrid antibody, the antigenicity is reduced. Preparation of these hybrid antibodies may be carried out by methods well known in 25 the art.

Preferred antibodies are those monoclonal or polyclonal antibodies which specifically recognize and bind to human RAGE proteins and more particularly, those that specifically bind to the human soluble RAGE polypeptides of the invention. Accordingly, these preferred antibodies will specifically recognize and 30 bind the polypeptides which have an amino acid sequence that is substantially homologous to the amino acid sequence shown in Figure 1A and 1B (Seq ID NOS: 2 and 4), or immunologically active fragments thereof. Still more preferred are antibodies which are capable of forming an antibody-ligand complex with the polypeptides of the invention, whereby the ability of the RAGE polypeptides to 35 associate with their ligands, *in vitro*, is reduced, e.g., blocking antibodies.

Also preferred are blocking antibodies which inhibit or reduce binding of RAGE to other natural and pathology associated ligands of human RAGE, e.g., amphotericin, β -amyloid peptides, and the like.

IV. Nucleic Acids and Cell Lines

In another aspect, the present invention provides nucleic acids which encode the polypeptides of the invention, as well as expression vectors that include these nucleic acids, and cell lines and organisms that are capable of expressing these nucleic acids. These nucleic acids, expression vectors and cell lines may generally be used to produce the polypeptides of the invention. Generally, the isolated nucleic acids of the present invention encode a polypeptide which is derived from or related to a soluble human RAGE polypeptide or biologically active fragment thereof.

In preferred aspects, the nucleic acid compositions of the invention will typically include a coding region which encodes a polypeptide having an amino acid sequence that is substantially homologous to the amino acid sequence shown in Figure 1A and 1B (Seq ID NOS: 1-4). Preferred nucleic acids will typically encode polypeptides having an amino acid sequence which is substantially homologous to the amino acid sequence shown in Figure 1A and 1B (Seq ID NOS: 1-4), or biologically active fragments thereof. Such fragments will generally comprise a segment of from about 15 to about 150 nucleotides. These fragments can be useful as oligonucleotide probes in the methods of the present invention, or alternatively to encode the polypeptides or biologically active fragments of the present invention, described herein. Also provided are substantially similar nucleic acid sequences, allelic variations and natural or induced sequences of the above described nucleic acids. Also included are chemically modified and substituted nucleic acids, e.g., those which incorporate modified nucleotide bases or which incorporate a labelling group.

More preferred nucleic acids will comprise a segment having more than about 20 contiguous nucleotides from the nucleotide sequences shown in either of Figure 1A or 1B (Seq ID NOS: 1 and 3), with still more preferred nucleic acids having a nucleotide sequence that is substantially homologous to either of the nucleotide sequences shown in Figure 1A or 1B (Seq ID NOS: 1 and 3). Most preferred nucleic acids are those which include a portion, i.e., at least 20 contiguous nucleotides, or all of the nucleotide sequence shown in Figures 1A or B (Seq ID NOS: 1 and 3).

"Nucleic acids" of the present invention include RNA, cDNA, genomic DNA, synthetic forms and mixed polymers, both sense and antisense strands. Furthermore, different alleles of each isoform are also included. The present invention also provides recombinant nucleic acids which are not otherwise naturally occurring. The nucleic acids described herein also include self replicating plasmids and infectious polymers of DNA or RNA. Unless specified otherwise, conventional

notation for nucleic acids is used herein. For example, as written, the left hand end of a single stranded polynucleotide sequence is the 5'-end, whereas the right-hand end is the 3'-end. The left hand direction of double-stranded polynucleotide sequences is referred to as the 5' direction. The direction of 5' to 3' addition of nascent RNA transcripts is referred to as the transcription direction; sequence regions on the DNA strand having the same sequence as the RNA and which are 5' to the 5' end of the RNA transcript are referred to as "upstream sequences"; sequence regions on the DNA strand having the same sequence as the RNA and which are 3' to the 3' end of the RNA transcript are referred to as "downstream sequences".

The phrase "nucleic acid sequence encoding" refers to a nucleic acid which directs the expression of a specific protein or peptide. The nucleic acid sequences include both the DNA strand sequence that is transcribed into RNA and the RNA sequence that is translated into protein. The nucleic acid sequences include both the full length nucleic acid sequences as well as non-full length sequences derived from the full length protein. It will be further understood that the nucleic acids of the invention also encompass degenerate codons of the native sequence or sequences which may be introduced to provide codon preference in a specific host cell.

Substantial homology in the nucleic acid context means that the segments, or their complementary strands, when compared, are the same when properly aligned, with the appropriate nucleotide insertions or deletions, in at least about 60% of the nucleotides, typically, at least about 70%, more typically, at least about 80%, usually, at least about 90%, and more usually, at least about 95% to 98% of the nucleotides. Alternatively, substantial homology exists when the segments will hybridize under selective hybridization conditions to a strand, or its complement, typically using a sequence of at least about 20 contiguous nucleotides derived from the nucleotide sequences shown in Figures 1A or 1B (Seq ID NOS: 1 and 3). However, larger segments will usually be preferred, e.g., at least about 30 contiguous nucleotides, more usually about 40 contiguous nucleotides, and preferably more than about 50 contiguous nucleotides. Selective hybridization exists when hybridization occurs which is more selective than total lack of specificity. See, Kanehisa, Nucleic Acid Res. 12:203-213 (1984). Examples of such selective hybridization conditions include, e.g., hybridization under the hybridization and wash conditions of 50% formamide at 42°C. Other stringent hybridization conditions may also be selected. Generally, stringent conditions are selected to be about 5° C lower than the thermal melting point (Tm) for the specific sequence at a defined ionic strength and pH. The Tm is the temperature (under defined ionic strength and pH) at which 50% of the target sequence hybridizes to a

perfectly matched probe. Typically, stringent conditions will be those in which the salt concentration is at least about 0.02 molar at pH 7 and the temperature is at least about 60°C. As other factors may significantly affect the stringency of hybridization, including, among others, base composition and size of the complementary strands, the presence of organic solvents and the extent of base mismatching, the combination of parameters is more important than the absolute measure of any one.

The nucleic acids of the present invention may be present in whole cells, cell lysates or in partially pure or substantially pure or isolated form. When referring to nucleic acids, the terms "substantially pure" or "isolated" generally refer to the nucleic acid separated from contaminants with which it is generally associated, e.g., lipids, proteins and other nucleic acids. The substantially pure or isolated nucleic acids of the present invention will be greater than about 50% pure. Typically, these nucleic acids will be more than about 60% pure, more typically, from about 75% to about 90% pure and preferably from about 95% to about 98% pure.

There are various methods of isolating the nucleic acids which encode the polypeptides of the present invention. Typically, the DNA is isolated from a genomic or cDNA library using labeled oligonucleotide probes specific for sequences in the desired DNA. Restriction endonuclease digestion of genomic DNA or cDNA containing the appropriate genes can be used to isolate the DNA encoding the polypeptides of the invention. From the nucleotide sequence given in Figures 1A or 1B (Seq ID NOS: 1 and 3), a panel of restriction endonucleases can be constructed to give cleavage of the DNA in desired regions, i.e., to obtain segments which encode biologically active polypeptides or fragments of the invention. Following restriction endonuclease digestion, DNA encoding the polypeptides of the invention is identified by its ability to hybridize with a nucleic acid probe in, for example, a Southern blot format. These regions are then isolated using standard methods. See, e.g., Sambrook, et al., *supra*.

The polymerase chain reaction, or "PCR" can also be used to prepare nucleic acids which encode the polypeptides of the present invention. PCR technology is used to amplify nucleic acid sequences of the desired nucleic acid, e.g., the DNA which encodes the polypeptides of the invention, directly from mRNA, cDNA, or genomic or cDNA libraries. Alternatively, solid phase oligonucleotide synthesis methods may also be employed to produce the nucleic acids described herein. Such methods include the phosphoramidite method described by, e.g., Beaucage and Carruthers, Tetrahedron Lett. 22:1859-1862 (1981), or the triester method according to Matteucci, et al., J. Am. Chem. Soc., 103:3185 (1981). A double stranded fragment may then be obtained, if desired, by annealing the

chemically synthesized single strands together under appropriate conditions or by synthesizing the complementary strand using DNA polymerase with an appropriate primer sequence.

- Appropriate primers and probes for amplifying the nucleic acids
- 5 described herein, may be generated from analysis of the nucleic acid sequences described herein, e.g., in Figure 1A or 1B (Seq ID NOS: 1 and 3). Briefly, oligonucleotide primers complementary to the two 3' borders of the DNA region to be amplified are synthesized. The PCR is then carried out using the two primers. See, e.g., PCR Protocols: A Guide to Methods and Applications (Innis, M., Gelfand, 10 D., Sninsky, J. and White, T., eds.) Academic Press (1990). Primers can be selected to amplify a variety of different sized segments from the nucleic acid sequence.

- In addition to their use in producing the polypeptides of the invention, the nucleic acid sequences described herein are also particularly useful in a number 15 of other applications. For example, in a particular aspect, the nucleic acid sequences of the present invention or fragments thereof, may be readily employed as nucleic acid probes useful in obtaining genes which encode the polypeptides of the present invention or other closely related genes. "Nucleic acid probes" may be DNA or RNA fragments. DNA fragments can be prepared, for example, by 20 digesting plasmid DNA, or by use of PCR, or synthesized by either the phosphoramidite or phosphotriester methods described in, e.g., Gait, Oligonucleotide Synthesis: A Practical Approach, IRL Press (1990). Where a specific sequence for a nucleic acid probe is given, it is understood that the complementary strand is also identified and included. The complementary strand 25 will work equally well in situations where the target is a double-stranded nucleic acid. Typical nucleic acid probes may be readily derived from the nucleotide sequence shown in Figure 1A or B (Seq ID NOS: 1 and 3), or alternatively, may be prepared from the amino acid sequence of soluble human RAGE polypeptides, as shown in Figure 1A or 1B (Seq ID NOS: 2 and 4). In particular, probes may be 30 prepared based upon segments of the amino acid sequence which possess relatively low levels of degeneracy, i.e., few or one possible nucleic acid sequences which encode therefor. Suitable synthetic DNA fragments may then be prepared.

- Such nucleic acid probes, e.g., cDNA probes, may be used in the design of oligonucleotide probes and primers for screening and cloning genes 35 which encode the polypeptides of the invention or related polypeptides, e.g., using well known PCR techniques. These nucleic acids, or fragments may comprise part or all of the cDNA sequence that encodes the polypeptides of the present invention. Effective cDNA probes may comprise as few as 15 consecutive nucleotides in the cDNA sequence, but will often comprise longer segments. Further, these probes

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- may further comprise an additional nucleotide sequence, such as a transcriptional primer sequence for cloning, or a detectable group for easy identification and location of complementary sequences. Examples of probes that are particularly useful in amplifying the nucleic acid sequence encoding soluble human RAGE as shown in Figure 1A or 1B, include those having the following sequences:
- 5' -GATGGCAGCCGGAACAGCAGTT-3' (Seq ID NO: 22); and
5' -CTCAAGTTCCCAGCCCTGATCCTCC-3' (Seq ID NO: 23).

cDNA or genomic libraries of various types may be screened for new alleles encoding RAGE or related sequences, using the above probes. The choice of cDNA libraries normally corresponds to tissue sources which are abundant in mRNA for the desired polypeptides, e.g., lung tissue. Phage or plasmid libraries may generally be used. Clones of a library are spread onto plates, transferred to a substrate for screening, denatured, and probed for the presence of the desired sequences.

15 In addition to comprising a segment which encodes one or more of the above described polypeptides or biologically active fragments, the nucleic acids of the present invention may also comprise a segment encoding a heterologous protein, such that the gene is expressed to produce the two proteins as a fusion protein, as substantially described above.

20 Typically, the nucleic acids of the present invention will be used in expression vectors for the preparation of the polypeptides of the present invention, namely those polypeptides which are derived from or related to soluble human RAGE or its biologically active fragments. The phrase "expression vector" generally refers to nucleotide sequences that are capable of affecting expression of a structural gene in hosts compatible with such sequences. These expression vectors typically include at least suitable promoter sequences and optionally, transcription termination signals. Additional factors necessary or helpful in effecting expression may also be used as described herein. DNA encoding the RAGE polypeptides of the present invention will typically be incorporated into DNA constructs capable of introduction into and expression in an *in vitro* cell culture. Often, the nucleic acids of the present invention may be used to produce a suitable recombinant host cell. Specifically, DNA constructs will be suitable for replication in a prokaryotic host, such as bacteria, e.g., *E. coli*, or may be introduced into a cultured mammalian, plant, insect, e.g., Sf9, yeast, fungi or other eukaryotic cell line. DNA constructs prepared for introduction into a particular host, e.g., insect or bacteria, will typically include a replication system recognized by the host, the intended DNA segment encoding the desired polypeptide, and transcriptional and translational initiation and termination regulatory sequences operably linked to the polypeptide encoding segment. A DNA segment is operably linked when it is

- placed into a functional relationship with another DNA segment. For example, a promoter or enhancer is operably linked to a coding sequence if it stimulates the transcription of the sequence. DNA for a signal sequence is operably linked to DNA encoding a polypeptide if it is expressed as a preprotein that participates in the secretion of the polypeptide. Generally, DNA sequences that are operably linked are contiguous, and in the case of a signal sequence both contiguous and in reading phase. However, enhancers need not be contiguous with the coding sequences whose transcription they control. Linking is accomplished by ligation at convenient restriction sites or at adapters or linkers inserted in lieu thereof. The selection of an appropriate promoter sequence will generally depend upon the host cell selected for the expression of the DNA segment. Examples of suitable promoter sequences include prokaryotic, and eukaryotic promoters well known in the art. See, e.g., Sambrook et al., Molecular Cloning: A Laboratory Manual (2d ed.), vols. 1-3 Cold Spring Harbor Laboratory (1989). The transcriptional regulatory sequences will typically include a heterologous enhancer or promoter which is recognized by the host. The selection of an appropriate promoter will depend upon the host, but promoters such as the trp, lac and phage promoters, tRNA promoters and glycolytic enzyme promoters are known and available. See Sambrook et al., (1989).
- Conveniently available expression vectors which include the replication system and transcriptional and translational regulatory sequences together with the insertion site for the polypeptide encoding segment may be employed. Examples of workable combinations of cell lines and expression vectors are described in Sambrook et al., and in Metzger et al., Nature 334:31-36 (1988).
- For example, suitable expression vectors may be expressed in, e.g., insect cells, e.g., Sf9 cells, mammalian cells, e.g., CHO cells and bacterial cells, e.g., E. coli.
- Where an insect cell line is selected as the host cell of choice to express the polypeptide, the cDNA encoding the polypeptides of the invention may be cloned into an appropriate baculovirus expression vector, e.g., pBacPAK8 vector (Clontech, Palo Alto, CA). The recombinant baculovirus may then be used to transfect a suitable insect host cell, e.g., Spodoptera frugiperda (Sf9) cells, which may then express the polypeptide. See, e.g., D.K. Morrison et al., Cell 58:649-657 (1989), M.D. Summers and G.E. Smith, A Manual of Methods for Baculovirus Vectors and Insect Cell Culture Procedures, Texas Agricultural Station, College Station, Texas (1987).

V. Methods of Use

The compositions of the present invention have a wide variety of uses, including, inter alia, screening, diagnostic and therapeutic applications.

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A. Screening Applications

In a preferred aspect, the polypeptides of the invention may be used as model systems for identifying effectors of the AGE/RAGE interaction. In 10 particular, these model systems may be used to screen collections or libraries of test compounds in order to identify agonists or antagonists of AGE/RAGE interaction. Generally, agonists, antagonists or test compounds may be chemical compounds, mixtures of chemical compounds, biological macromolecules, or extracts made from biological materials such as bacteria, plants, fungi, or animal 15 cells or tissues. Particularly targeted test compounds will typically include the polypeptides or fragments of the present invention as well as structural analogs or peptidomimetics which are derived from these polypeptides or the antibodies described herein, substrates or ligands thereof. As used herein, the term "agonist" refers to a composition or compound that will enhance the particular observed 20 activity, e.g., AGE/RAGE binding, while an "antagonist" will diminish the particular observed activity. The terms "agonist" and "antagonist", as used herein, do not imply any particular mechanism of function.

The screening methods of the present invention typically involve the incubation of a polypeptide of the present invention, e.g., a soluble human RAGE 25 polypeptide, in the presence of a standard advanced glycosylation end-product protein (AGE) such as AGE-BSA, nonenzymatically N-glycosylated collagen, myelin or the like, as well as the test compound. Typically, one of the RAGE polypeptide or AGE will be immobilized upon a solid support which will then be contacted with the other protein or peptide. The other, non-immobilized member of the AGE/RAGE 30 pair will typically include a labeling group covalently or otherwise attached so as not to interfere with the AGE/RAGE interaction. Labeling groups will generally include those that are substantially set out above. Immobilization of one of the AGE or RAGE polypeptide permits ready separation of AGE/RAGE complex, which will be bound to the solid support, from unreacted or free AGE or RAGE, utilizing a simple 35 wash step.

A number of suitable solid supports may be employed for immobilization of the AGE or RAGE polypeptides. Examples of suitable solid supports include agarose, cellulose, dextran, Sephadex, Sepharose, carboxymethyl cellulose, polystyrene, filter paper, nitrocellulose, ion exchange resins, plastic films,

B. Affinity Ligands

In addition to their use as screening systems, the peptides of the invention may also be used as affinity ligands which specifically bind to AGEs. As 5 affinity ligands, these polypeptides may also be useful in the purification of AGEs from a mixture of different proteins. Affinity purification of AGEs may be carried out using affinity purification methods that well known in the art. For example, the soluble RAGE polypeptide or peptides may be attached to a suitable solid support as described above. Many solid supports are commercially available from, e.g., 10 Sigma Chemical Co., St Louis, Missouri, or Pharmacia, Uppsala, Sweden, and come prepared for immediate coupling of affinity ligands.

The mixture of proteins may be contacted with the polypeptide bound to the solid support, such that the RAGE polypeptide immobilized upon the solid support can selectively bind the AGEs within the mixture of proteins. The bound 15 protein can then be washed to eliminate unbound proteins. Finally, substantially pure AGEs may be eluted from the solid support by generally known elution protocols, e.g., changing buffer conditions, temperature, or level of carbohydrate in the elution buffer.

As affinity probes, the polypeptides of the invention may also be used 20 to bind AGEs both *in vitro* and *in vivo*. This binding may be used in assay formats to label and detect AGEs in a sample, imaging formats to identify localization of AGEs in a patient, or in therapeutic applications to deliver a drug to areas which are relatively high in AGE concentration, or specifically deliver a drug, e.g., a proteolytic drug, to an AGE.

25 In a similar manner, the antibodies of the invention may also be used as affinity probes or ligands for soluble RAGE polypeptides. In particular, the specificity of the antibodies of the invention may be exploited in the purification and/or identification of RAGE polypeptides and particularly, soluble human RAGE polypeptides.

30

C. Diagnostic Applications

As alluded to above, the polypeptides of the invention may be used as 35 probes capable of specifically interacting with their ligands, i.e., AGEs. As a result, the polypeptides of the invention may be used in a variety of diagnostic applications. For example, those polypeptides of the invention that are capable of specifically interacting with AGEs may be particularly useful in identifying patients who may suffer from abnormal levels of AGEs which are indicative of particular

- glass beads, polyaminemethylvinylether maleic acid copolymer, amino acid copolymer, ethylene-maleic acid copolymer, nylon, silk, etc. The support may be in the form of, e.g., a test tube, microtiter plate, beads, test strips, or the like. The reaction of the AGE or RAGE polypeptide with the particular solid support may be
- 5 carried out by methods well known in the art. For example, in some cases, supports bearing lectins, e.g., Con-A, may be employed for immobilization of the AGEs. Alternatively, a variety of pre-derivatized solid supports to which AGEs may be covalently attached are generally available from, e.g., Sigma Chemical Co. (St. Louis, MO), and Pharmacia (Upsalla, Sweden).
- 10 In the case of a microtiter plate, the test compound may be added to the well of the microtiter plate to preincubate with the immobilized AGE or RAGE polypeptide. The remaining member of the RAGE/AGE pair, bearing a suitable labeling group as described previously, may then be added to the microtiter well. Following suitable incubation, the wells are washed, and the amount of bound label
- 15 is determined, e.g., by scanning the plate with a suitable optical reader, e.g., plate reader. The level of binding is then compared to suitable positive and negative controls or a set of standards containing a known range of agonists or antagonist concentrations. Alternatively, by providing the polypeptide containing the RAGE and AGE polypeptides in known concentrations, one can assay for the level of free
- 20 or unbound RAGE or AGE, and by negative implication, determine the level of RAGE/AGE complex which is formed.
- In some cases, identification of complexed AGE/RAGE may be carried out by other means, i.e., without the use of a support bound peptide. For example, well known quantitation methods, such as HPLC and the like may be utilized to
- 25 separate and identify complexed AGE/RAGE polypeptides from the free or uncomplexed proteins. Again, this may allow determination and comparison of the amount of either the free or bound material remaining after incubation with the test compound.
- 30 Where the presence of the test compound results in a decrease of the amount of RAGE/AGE complex formed, it will be indicative that the test compound is an antagonist of the RAGE/AGE interaction. Where, however, the presence of a test compound results in an increase or enhancement of RAGE/AGE interaction, it will be indicative that the compound is an agonist of the RAGE/AGE interaction. Test compounds which are indicated to be antagonists of the RAGE/AGE
- 35 interaction may be further characterized in additional studies, e.g., clinical trials.

disorders, or may be viewed as indicators of future problems, such as diabetic vasculopathy.

- In a particular aspect, soluble human RAGE polypeptides may be used as affinity probes to identify the presence, absence and/or relative quantity of
- 5 AGEs in a sample, e.g., blood or tissue samples from a patient. This allows the identification of patients having elevated levels of AGE or other ligands of RAGE, which levels are indicative of a variety of pathological conditions associated with, e.g., Diabetes Mellitus, peripheral occlusive vascular diseases, hemodialysis-associated amyloidosis, Alzheimer's disease and other age-related disorders. Once
- 10 a patient is diagnosed as suffering from one or more of these complications, or is identified as being at a higher risk, appropriate preventative or therapeutic measures may be taken, such as administration of appropriate pharmaceutical agents, e.g., compositions comprising the peptides, peptidomimetics or antibodies of the invention.
- 15 In a similar manner, the antibodies of the present invention, e.g., those that are specifically immunoreactive with human RAGE polypeptides, may be used to diagnose disorders characterized by abnormal levels or localization of AGE/RAGE interactions. In particular, the described antibodies may be used as diagnostic tools to evaluate plasma and tissue levels of RAGE in patients suffering
- 20 from pathological conditions associated with elevated levels of AGE/RAGE interaction. In particular, the antibodies described herein may be used in well known immunoassay formats, e.g., ELISA, Western blotting, immunohistochemistry and FACS methods, to identify levels of RAGE in samples.

25 D. Therapeutic Applications

In addition to the above described uses, the soluble RAGE polypeptides and antibodies of the invention may also be used in therapeutic applications for the treatment of human or non-human mammalian patients. The

30 term "treatment" as used herein, refers to the full spectrum of treatments for a given disorder from which the patient is suffering, including alleviation of one, most or all symptoms resulting from that disorder, to an outright cure for the particular disorder or prevention of the onset of the disorder.

In particular, the polypeptides and antibodies of the invention are useful in treating disorders or symptoms of which result from excessive levels of AGEs in tissue or plasma. As described previously, the association of AGEs and RAGE has been implicated as a symptom or causative event in a number of pathological conditions including, e.g., complications associated with Diabetes Mellitus, e.g., diabetic microvasculopathy (neuropathy, nephropathy and

- retinopathy), diabetic macrovasculopathy (atherosclerosis), occlusive vascular disorders, activation of microglial cells by β -amyloid peptides in Alzheimer's disease, hemodialysis-associated amyloidosis and age related disorders such as oxidant stress. Accordingly, treatment or prevention of such disorders may 5 generally be carried out by reducing, inhibiting or outright blocking the interaction between AGEs and RAGE. Blocking this interaction typically involves administering to a patient an effective amount of a soluble human RAGE polypeptide, peptidomimetic or blocking antibody, as described above.

The term "patient" generally refers to a mammalian individual, typically 10 human, who has been diagnosed as suffering from one or more of the above described disorders, or who has been characterized as belonging to a group that has an abnormally high incidence of such disorders, e.g., diabetics and the elderly.

The term "effective amount" or "therapeutically effective amount" generally refers to the quantities of reagents necessary for effective therapy, i.e., 15 the partial or complete alleviation of the symptom or disorder for which treatment was sought. Included within the definition of effective therapy are preventative treatments intended to reduce the likelihood of onset of the above-described symptoms or disorders. The effective amount for a given therapy, whether curative or preventative, will generally depend upon many different factors, including means 20 of administration, target site, physiological state of the patient and other medicants administered. Thus, treatment doses will need to be titrated to optimize safety and efficacy. Typically, dosages used *in vitro* may provide useful guidance in the amounts useful for *in situ* administration of these reagents. Animal testing of effective doses for treatment of particular disorders will provide further predictive 25 indication of human dosage. Generally, therapeutically effective amounts of the polypeptides or blocking antibodies of the present invention will be from about 0.0001 to about 10 mg/kg, and more usually, from about 0.001 to about 0.1 mg/kg of the host's body weight. Various considerations are described, e.g., in Gilman et al., (Eds.), *Goodman and Gilman's: The Pharmacological Basis of Therapeutics*, 30 (8th ed. 1990), Pergamon Press, and *Remington's Pharmaceutical Sciences* (7th ed. 1985) Mack Publishing Co., Easton, Penn.

Methods of administration, also discussed in the above references, include, e.g., oral, intravenous, intraperitoneal or intramuscular administration, and local administration, including topical, transdermal diffusion and aerosol 35 administration, for therapeutic, and/or prophylactic treatment. The active agent, i.e., the polypeptide or antibody component, will generally be administered in a composition additionally comprising a pharmaceutically acceptable carrier. Suitable pharmaceutically acceptable carriers include water, saline, buffers and other compounds described in, e.g., the *Merck Index*, Merck and Co., Rahway, New

Jersey. For some methods of administration, e.g., oral, it may be desirable to provide the active ingredient in a liposomal formulation. This is particularly desirable where the active ingredient may be subject to degradative environments, for example, proteolytic digestive enzymes. Liposomal formulations are well known 5 in the art, and are discussed in, e.g., Remington's Pharmaceutical Sciences, *supra*. Administration may also be carried out by way of a controlled release composition or device, whereby a slow release of the active ingredient allows continuous administration over a longer period of time.

Constituents of pharmaceutical compositions, in addition to the active 10 agents described herein, include those generally known in the art for the various administration methods used. For example, oral forms generally include powders, tablets, pills, capsules, lozenges and liquids. Similarly, intravenous, intraperitoneal or intramuscular formulations will generally be dissolved or suspended in a pharmaceutically acceptable carrier, e.g., water, buffered water, saline and the like. 15 Additionally, these compositions may include additional constituents which may be required to approximate physiological conditions, such as pH adjusting and buffering agents, tonicity adjusting agents, wetting agents and the like. For solid compositions, conventional nontoxic solid carriers may be used which include, e.g., pharmaceutical grades of mannitol, lactose, starch, magnesium stearate, sodium 20 saccharin, talcum, cellulose, glucose, sucrose, magnesium carbonate and the like.

Administration may also be carried out by way of a controlled release composition or device, whereby a slow release of the active ingredient allows continuous administration over a longer period of time.

The present invention is further illustrated by the following examples. 25 These examples are merely to illustrate aspects of the present invention and are not intended as limitations of this invention.

VI. Examples

- 30 **Example 1:** Cloning, Expression and Purification of Soluble Human RAGE
A DNA fragment coding for human soluble RAGE was obtained from lung cDNA library using polymerase chain reaction techniques (PCR, GeneAmp, Perkin-Elmer Cetus); primers used were 5'-GATGGCAGCCGG AACAGCAGTT-3' (Seq ID NO: 22) and 5'-CTCAAGTTCCCAGCCCTGATCCTCC-3' (Seq ID NO: 23).
35 The DNA sequence of the PCR product was confirmed by the dideoxy chain termination method (Sanger, et al., Proc. Nat'l Acad. Sci. USA 74:5463-5467 (1977). The DNA fragment was subcloned into the pCRII™ vector (Invitrogen, San Diego, CA) and the EcoR1 fragment of the resulting plasmid was cloned into the pBacPAK8 vector (Clontech, Palo Alto, CA) under control of the AcMNPV

polyhedrin promoter (ATCC Accession Nos. VR-2538 and VF-25-39). Baculovirus expression of recombinant human soluble RAGE was performed by co-transfected the plasmid pBacPAK8/RAGE with a linearized BacPAK6 viral cDNA (Clontech) into *Spodoptera frugiperda* (Sf9) cells according to the manufacturer's instructions.

- 5 Recombinant plaques were identified and purified by their beta-galactosidase negative phenotype.

Sf9 cells expressing soluble RAGE were grown as follows: Non-infected Sf 9 cells were grown in shake flasks at 28°C, to a density of 1 - 1.2 x 10⁶/ml in TNMF (Grace's with supplements from Sigma) plus 10% FBS (e.g.

- 10 Hyclone) and 0.1% pluronic F-68 (Sigma), and a viability of >97%. One liter of cells was infected with viral stock (MOI of ~ 0.01). Cultures were harvested 3 days post-infection by centrifuging the media at 1200 rpm for 8 min. This media was then used for purification of recombinant soluble RAGE.

- Recombinant human soluble RAGE was purified from the Sf9 media
15 by chromatography on an SP Sepharose fast flow column (Pharmacia) followed by a size exclusion chromatography step. In particular, a 1/10 volume of 1.0 M Tris-HCl, pH 8.0 was added to Sf 9 cell media to precipitate viral proteins and the media was allowed to sit at 4°C for several hours to allow precipitation. The precipitated media was centrifuged at ~ 3000 rpm for 10 to 15 min to remove any precipitate.
20 The supernatant was diluted 1:4 with deionized water, adjusted to pH 7.5 and sterile filtered (0.2 µm). The filtered supernatant was loaded onto SP Sepharose fast flow column (#17-0729-01, Pharmacia), that had been equilibrated with 20 mM NaPO₄, pH 7.5. The column was eluted in a salt gradient from 0 to 0.5 M NaCl, and the fractions were analyzed by SDS-PAGE. Fractions containing RAGE were pooled,
25 concentrated and diafiltered into PBS buffer.

Further purification was obtained by applying the pooled fractions to a Superdex 200PG column, and again, fractions were analyzed by SDS-PAGE and pooled as appropriate.

- 30 Example 2: Solid Phase Binding Assays for Soluble Human RAGE

Two assay formats were used to assess the ability of soluble RAGE to bind AGE. The first provided a RAGE polypeptide immobilized directly to the solid support whereas the second method employed an indirect attachment to more closely mimic the cell surface presentation of the AGE binding portion of

- 35 RAGE.

A. Preparation of AGE-BSA and ^{125}I -AGE-BSA

Bovine serum albumin (from Sigma, Cat #A7888) was incubated at a concentration of 25 mg/ml in phosphate buffered saline (calcium- and magnesium-free) with 250 mM ribose, in the presence of 1.5 mM PMSF (phenylmethylsulfonyl fluoride) and 1 mM EDTA (ethylenediaminetetraacetic acid). The pH of the solution was adjusted to between 6.8 and 7.0. The solution was sterilized by filtering through 0.22 micron filters and incubated in dark, at 37°C for 6 to 8 weeks. The solution containing AGE-BSA was dialysed against calcium- and magnesium-free PBS, and stored frozen in aliquots at -20°C.

100 µg of AGE-BSA was iodinated with 1 mCi of Na¹²⁵I using iodogen method according to the manufacturer's specifications. 4 µl of AGE-BSA (~ 100 µg), 8 µl of Na¹²⁵I (1 mCi) and 88 µl of phosphate buffered saline was added to a tube containing iodo-gen (Pierce). The tube was incubated for 15 minutes on ice, with occasional agitation. The reaction was terminated by adding 50 µl of 0.1% potassium iodide. The reaction mixture was passed over a desalting column to remove free iodine.

B. Competitive Binding of AGE to Indirectly Immobilized RAGE

20 A 96-well plate (Immunolon 4 from Dynatech Lab) was coated with anti-flag peptide antibodies (Eastman Kodak), 100 µl/well of 17 µl/ml in sodium bicarbonate buffer, pH 9.6) at 4°C overnight. The wells were washed and blocked as above. The wells were then incubated with Sf 9 media containing human recombinant soluble RAGE(flag fusion protein (75 µl of 1:4 dilution with PBS) 1 to 2 h at 37°C (flag peptide: DYKDDDDK). The wells were again washed as before and incubated with various concentrations of ^{125}I -AGE-BSA alone or in the presence of excess cold AGE-BSA (i.e., nonradioactive) in PBS containing 0.2% BSA (45 µl/well) at room temperature for 2-3 hours. The sample having an excess of cold AGE-BSA was used to account for nonspecific interactions. The wells were washed twice with 0.2% BSA in PBS. The bound ligand was then eluted with PBS containing 1 mg/ml of heparin and 1 mg/ml of BSA (100 µl/well) by incubating at 37°C for 5 minutes and counted. Figure 2 shows a graph of AGE binding to indirectly immobilized RAGE (expressed as CPM) as a function of increasing ligand concentration, in the absence and presence of excess nonradioactive ligand (Figure 2A), and corrected for nonspecific interactions (Figure 2B).

Example 3: Competition Binding Assays Using Soluble Human RAGE

Competition assays were also performed between ^{125}I -AGE-BSA and an excess of a number of other proteins, including soluble RAGE, Soluble RAGE/flag fusion protein, recombinant soluble RAGE/DCC chimeric protein (where the first Ig-like domain of RAGE is substituted with the first Ig-like domain of DCC, another Ig-superfamily member), lactoferrin and native BSA. The results are shown in Table 1, below.

Table 1

	Results of Competition Binding Assay (% Binding)		
	Exp. 1	Exp. 2	Exp. 3
^{125}I -AGE-BSA only	100%	100%	100%
+ cold AGE-BSA	29%	14%	12%
+ rec. solRAGE	n.d.	65%	60%
+ rec. solRAGE/flag fusion	8%	n.d.	n.d.
+ rec. solRAGE/DCC chimeric	40%	n.d.	n.d.
+ lactoferrin	n.d.	50%	20%
+ native BSA	n.d.	>100%	>100%

10

n.d. - Not determined

Binding assays were done in quadruplicate. Lactoferrin has been previously shown to bind AGEs. Li et al. Nature med. 1(10):1057-1061 (1995). Furthermore, lactoferrin was also shown to bind to RAGE Schmidt et al., J. Biol. Chem. 269:9882-9888 (1994), Yan et al., J. Biol. Chem. 269:9889-9897 (1994). However, as is apparent from the Table 1, binding of lactoferrin to RAGE or AGE does not facilitate further binding of AGE-BSA to RAGE. Figure 3 is dose response curve for the formation of RAGE/AGE binding complex in the presence of increasing concentrations of soluble RAGE polypeptide. As shown, increasing concentration of soluble RAGE increased the levels of AGE/RAGE binding until a plateau was reached.

25

Example 4: Preparation of Antibodies to Human Soluble RAGE

Monoclonal antibodies were generated from mice immunized with the human soluble RAGE extracellular domain expressed in baculovirus as described above.

5 Hybridoma preparation: Pairs of mice from three strains (Balb/C, Swiss Webster, and RBF/DnJ) were immunized with 100 µg soluble RAGE in complete Hunter's adjuvant, intradermally, on days 0, 7, and 21. Sera were drawn on day 28, and titers tested by EIA of soluble RAGE and FACS analysis of CHO-RAGE transfectants. Two mice were selected as lymphocyte donors, and received
10 10 µg soluble RAGE IV 72 hours before fusion. Splenocytes from these mice were fused with the mouse myeloma P3X63Ag8.653, and the resultant fusion products were selected with hypoxanthine-aminopterin-thymidine (HAT). Following HAT selection, supernatants from 2100 clones were tested in direct EIA with soluble RAGE. Seventy two strongly positive clones were isolated and then tested for
15 reactivity to CHO RAGE transfectant cells, of which 69 clones were positive. Selected hybridomas were serially subcloned 3X by limiting dilution, and ascites induced in pristane primed IRCF1 mice. The antibodies were purified by affinity chromatography (Protein G) followed by ion exchange chromatography (Q-Sepharose). Purity was tested by reduced SDS-PAGE, and isotype analysis was
20 done by radial immunodiffusion.

The resultant panel was tested for reactivity by EIA, Western blot, and FACS analysis of CHO cells transfected with full length RAGE. The antibodies were also analyzed for epitope variance by competition, and reactivity with RAGE/DCC chimeric protein. Complementary pairs of antibodies were selected,
25 and antigen capture EIAs specific for human, rat, and mouse RAGE were designed, with sensitivity in the nanogram range.

EIA: Direct antibody capture EIA was done by coating 96-well microtiter plates with 1 µg/well antigen in PBS, and incubating overnight at 4 C. Wells were blocked with PBS/1% BSA or casein, anti-RAGE antibodies added as
30 either neat tissue culture supernatant or 1 µg/well diluted in PBS/1% BSA and incubated for 2 hours at ambient room temperature. After washing 3X with PBS, anti-mouse IgG-alkaline phosphatase was added, and substrate degradation analyzed at 405 nm with a UVMax plate reader.

Antigen capture (sandwich) EIAs were done as above, with the
35 additional step of coating wells with 2 µg anti-RAGE monoclonal antibody diluted in carbonate buffer, pH 9.6, before addition of antigen.

Western Blot: Cell culture supernatants containing human, rat, or mouse RAGE were harvested, and size fractionated on denaturing SDS-PAGE

gels. The proteins were transferred to nitrocellulose, incubated with anti-RAGE antibody, and developed using an Amersham detection kit.

FACS analysis: Cells (CHO-RAGE, parental CHO, mouse macrophage, and human smooth muscle aorta) were harvested, and incubated with 5 μ g per 10^6 cells anti-RAGE antibody for 45 minutes on ice. After washing with cold PBS, cells were then incubated with anti-mouse IgG-FITC or phycoerythrin for 45 minutes on ice and then washed with PBS. Cells were analyzed for mean channel fluorescence with a Becton-Dickinson FACScan.

Ligand binding analyses and antibody competition studies were done 10 as above, with additional incubations with lactoferrin, and double labelled detection with anti-lactoferrin antibody in parallel with the anti-RAGE antibody.

The direct antibody capture EIA was used as the initial fusion screen to identify positive clones. The assay format was also utilized to determine reactivity with the RAGE chimeric RAGE/DCC protein in which the first 15 immunoglobulin-like domain was replaced with that of DCC. The assay results for the first 20 MAbs are shown in Figure 4. Four MAbs recognized both intact soluble RAGE polypeptide as well as the chimeric protein indicating epitope location outside the first Ig-like domain.

Eleven antibodies were also screened for binding to soluble human 20 RAGE polypeptide fragments as compared to their binding to soluble human RAGE. Figure 4B shows an antigen capture assay utilizing peptide fragment # 2 (WKLNTGRTEAC) (Seq ID NO: 6). The 11 antibodies were also tested for binding to immobilized RAGE in the presence and absence of free soluble RAGE or RAGE 25 polypeptide fragment # 1 (CKGAPKKPPQ) (Seq ID NO: 5), fragment # 2 (WKLNTGRTEAC) (Seq ID NO: 6) and fragment # 8 (GPQDQGTYSC) (Seq ID NO: 7). The results are shown in Figure 4C.

The sandwich EIA using MAbs RBF9D9 (ATCC Accession No. HB-12165) as capture and SW10C1-biotin (ATCC Accession No. HB-12164) as 30 detection is specific for human RAGE, and does not cross react with either rat or mouse RAGE. This assay was used to detect and quantitate the presence of RAGE expressed in baculovirus, as well as CHO cells (Figure 6A). Controls included a concentration range of purified RAGE for generation of a standard curve, as well as RAGE-spiked sera controls; the range of linearity is 20 - 100 ng/well.

A second sandwich EIA, specific for human, rat, and mouse RAGE, 35 uses MAbs RBF9D9 (ATCC Accession No. HB-12165) as capture and SW1E8-biotin (ATCC Accession No. HB-12166) as detection. This assay was used to detect and quantitate recombinant RAGE expressed in insect and mammalian cells (Figure 6B), and sera obtained from lean and obese rats (not shown), including

controls as above. Western blot analysis of the antibodies confirms reactivity to RAGE as shown in Figure 5.

Sixty-nine of the 72 anti-RAGE MAbs were positive for binding to cell surface RAGE, as determined by direct immunofluorescent staining of CHO-RAGE transfectant cells. Data from one binding experiment is shown in Figure 7. The other 68 binding MAbs showed similar results. Additional FACS experiments included direct immunofluorescent staining of cells with anti-RAGE MAbs SW10C1 (ATCC Accession No. HB-12164), SW1E8 (ATCC Accession No. HB-12166), and RBF9D9 (ATCC Accession No. HB-12165), all of which strongly recognize cell surface RAGE.

Binding of exogenous lactoferrin, however, was clearly demonstrated on the CHO-RAGE transfectants as shown in Figure 8B. In particular, parental and RAGE transfected CHO cells were separately incubated with 5 µg lactoferrin and stained with both anti-RAGE/phycoerythrin and anti-lactoferrin/FITC. Phycoerythrin fluorescence shown in Figure 8A, indicates the presence of RAGE on the cell surface. FITC fluorescence shown in Figure 8B indicates the binding of lactoferrin to CHO-RAGE transfectants, but not to parental CHO cells.

Epitope analysis: The results of competition experiments, binding to the deletion mutant, and binding to rat and mouse RAGE clearly indicate that the panel of MAbs recognize unique and discrete antigenic determinants. Four MAbs recognize epitopes on the second or third Ig-like domains. One of these four recognizes an epitope that is exposed on the extracellular RAGE, but not cell surface RAGE, perhaps due to proximity to the cell surface. The remaining 69 MAbs recognize epitopes on the first Ig-like domain, and bind to at least four different sites on this domain.

Example 5: Effects of Soluble RAGE on Vascular Permeability

Early changes in vascular permeability are widely recognized as a hallmark of diabetic vascular dysfunction. As a result, the effect of recombinant soluble RAGE was tested in permeability models. See, e.g., Vlassara et al., *Laboratory Invest.* 70(2):138-151 (1994), Vlassara et al., *Proc. Nat'l Acad. Sci. USA* 91:11704-11708 (1995).

A. In vitro permeability studies

Bovine aortic endothelial cells (BAEC) were cult-Cured to confluence on nucleopore membranes. Seven days after reaching confluence, cells were incubated for 24 hours with red blood cells (RBCs) isolated from either normal subjects or diabetic patients. Endothelial cells were washed and permeability was

measured in a permeability chamber containing minimal essential medium containing 10% fetal calf serum by adding ^{125}I -albumin or ^3H -inulin to the upper chamber. The emergence of radioactivity in the lower chamber was then measured over 24 hours at 37°C. Aliquots of medium (5 μl) were sampled from the upper and 5 lower chambers every 10 minutes for the first hour and at 1, 2, 4 and 24 hour time points to determine a permeability coefficient.

To determine the effect of recombinant soluble RAGE on in vitro permeability, normal or diabetic RBCs were first incubated with recombinant RAGE or control proteins (VCAM-1)(30 $\mu\text{g}/\text{ml}$) before adding to the endothelial cells.

10 Determination of permeability coefficient (P) was carried out by the following calculation:

$$P = (J)(1/A)(1/(C_t - C_b))$$

where J is the flux of molecules across the filter, A is the surface area of the confluent layer of endothelial cells, C_t is the concentration of tracer in the upper 15 chamber and C_b is the concentration of tracer in the lower chamber. Post-confluent monolayers displaying permeability coefficients greater than $6.5 \times 10^{-7} \text{ cm/s}$, for albumin, or greater than $5 \times 10^{-6} \text{ cm/s}$ for inulin were excluded.

When endothelial cells were exposed to diabetic RBCs, the permeability of the monolayer to both macromolecules and micromolecules 20 increased (Figure 9A and 9B, respectively) compared with endothelial cells exposed to normal RBCs. This increased permeability was reversed by preincubation of diabetic RBCs with recombinant soluble RAGE, but not with the recombinant soluble control protein (VCAM-1, consisting of the first 3 Ig-like domains of VCAM-1 and having a structure similar to RAGE)(Figure 9A and 9B).

25

B. TBIR (tissue-blood-isotope ratio) Studies

These studies were performed with normal and diabetic male Wister rats. Diabetes was induced in the rats by intravenous injection of streptozocin (45 30 mg/Kg) into animals weighing approximately 200 g. Animals were maintained for 9 to 11 weeks post-STZ prior to commencing the TBIR studies. Hyperglycemia (35-40 mmol/liter) was confirmed in diabetic rats.

RBCs were collected from normal or diabetic rats by puncturing the lower abdominal aorta. The RBCs were collected in a solution of dextrose (2.4%), 35 citric acid (2.4%), sodium citrate (0.73%) and 2 parts anticoagulant to 8 parts blood. Blood was centrifuged to remove plasma and buffy coat, and the packed RBCs were washed and infused (4.2×10^9 cells/animal) into normal syngeneic animals (vol. 0.5 ml). After one hour, TBIR was determined by infusion of ^{125}I -albumin

followed 30 minutes later by infusion of ^{51}Cr -labelled normal RBCs. Tissue and blood samples were collected 5 minutes later.

To test the effect of recombinant soluble RAGE (and the recombinant control protein), normal or diabetic RBCs were pretreated with the recombinant proteins (60 $\mu\text{g}/\text{ml}$ RBCs) prior to infusion. Six animals were used per group.

Pretreatment was carried out as follows: Diabetic rats were infused with either recombinant soluble RAGE or recombinant soluble VCAM-1 (control) (5.15 mg/Kg) 1 hour prior to TBIR measurement. In order to determine the dose of recombinant protein required to achieve a plasma concentration of 30 to 60 $\mu\text{g}/\text{ml}$, pharmacokinetic studies were performed using ^{125}I -labelled recombinant soluble RAGE, the results of which are provided in Figure 10. Radioactivity was measured as the trichloroacetic plasma precipitable fraction. Plasma human recombinant soluble RAGE concentration data were fit to a two compartment open model using nonlinear regression by extended least squares analysis (Siphar, SIMED, Cretail, France). The elimination and distribution half-lives were 26 and 0.13 hours, respectively. For TBIR studies, 10 control diabetic rats were used, 7 diabetic rats were treated with soluble RAGE and 5 rats were treated with the control protein.

TBIR was calculated as a ratio of $[^{125}\text{I}]/[^{51}\text{Cr}]$ in tissue over the same ratio in blood. One way analysis of variance followed by Dunnet's test was used to analyze the data for each organ. The results for normal and diabetic rats are given in figures 12A and 12B, respectively.

In normal animals infused with diabetic RBCs, TBIR increased in a number of tissues as compared to infusion of normal RBCs (Figure 11A). Most of the increases in TBIR were prevented by pretreatment of diabetic rats with recombinant soluble RAGE, but not with the control protein, with the exception of kidney tissue, which showed a similar effect with both RAGE and VCAM-1. These results indicate that AGEs on the surface of diabetic RBCs interact with surface RAGE on endothelial cells, triggering activation of the latter cells. This leads to an increased permeability of the endothelial layers. Without being bound to a particular theory, it is believed that pretreatment of diabetic RBCs with soluble RAGE prevents this interaction and, as a result, prevents increases in permeability as demonstrated.

TBIR also increased in various tissues of diabetic rats as compared to those of normal rats. The increase in TBIR observed in some tissues, e.g., kidney, is reversed by acute administration of recombinant soluble RAGE. In other tissues, e.g., intestine, skin, both recombinant soluble RAGE and control protein had some effects (Figure 11B). TBIR results in diabetic rats were not as clear as those for normal rats. This is believed to be a result of diabetes associated changes in hemodynamic factors that may effect TBIR. Accordingly, additional assays were

performed to confirm the efficacy of RAGE in preventing diabetes associated increases in permeability.

C. Albumin Clearance Studies in STZ-induced Diabetic Rats

5

Young adult Sprague-Dawley rats (male, 6 weeks old, 150 g) were used. Diabetes was again induced by intravenous injection of streptozocin (65 mg/kg, available from Sigma Chemical Co.). Urine output and animal weight were monitored and blood samples collected weekly (tail clip sampling) for determination 10 of serum glucose concentrations (glucose oxidase method). Animals rendered diabetic ($[glucose] > 30\text{mM}$) were used for experimental protocols. Rats were anesthetized with isoflurane (1.5-2%) in the day of the experiment. Cannulae were placed in the jugular veins and left carotid artery. Five percent BSA (6 mg/Kg) was administered to compensate for fluid and protein losses during surgery. The 15 animals were allowed to stabilize for 20-30 minutes prior to treatment.

For animals that received recombinant proteins, the following additional treatments were performed prior to infusion of a tracer: Recombinant soluble RAGE purified according to the methods described above was administered at infusion rates to achieve plasma concentrations of 60-80 $\mu\text{g/ml}$ for 1.5 hours. 20 Arterial pressure, right atrial pressure, and body temperature were continuously monitored. Western blotting was performed on plasma samples and standards to determine the level of circulating recombinant protein during the studies.

Albumin extravasation (albumin clearance, C_{RSA}) into individual tissues was calculated as the difference between the 35 minute ^{131}I -RSA (rat serum 25 albumin)(injected at $t=0$) and 5 minute ^{125}I -RSA (injected at $t=30$ minutes) distribution volumes (See Figure 12). A 30 minute clearance period was chosen in order to minimize loss of extravasated tracer from high permeability tissues (i.e., gut, kidney). Twenty tissue samples were surveyed in the studies: skin (hindlimb and back); skeletal muscle (gastrocnemius, tibialis anterior, abdominal wall); heart 30 (left ventricle); lung (right and left lower lobe); lower trachea; aorta, sciatic nerve; retina; kidney; pancreas, jejunum, ileum, colon, testis, cerebrum and visceral fat pad. Initial and final plasma volumes were estimated as the 5 minutes ^{131}I -RSA and ^{125}I -RSA distribution volumes, respectively. Tissue extravascular water contents (EVW) were determined as (wet weight)-(125I-RSA volume)-(dry weight). Values of 35 C_{RSA} and EVW were normalized to tissue blood-free dry weight. The data were separated into early (2-3 weeks), mid (4-10 weeks), and late (11-20 weeks) phases following streptozocin injection for comparison.

Regression analysis was performed on individual values of C_{RSA} (over 30 minutes) plotted as a function of paired values of EVW. The slope of this

relationship approximates the ratio of filtrate to plasma albumin concentration (i.e., the solvent drag coefficient). For hindlimb skin and skeletal muscles, the regression analyses were performed on differences in C_{RSA} and EVW between paired hindlimbs (congested vs. non-congested). The results are shown in Figures 13A (early), 13B (mid) and 13C (late).

Over the 20 week "post-STZ treatment" period, there were increases in albumin clearance in visceral fat (+385%) in the early phase, and in skin (+75%), skeletal muscle (+68%) aorta (80%) and trachea (+84%) in the late phase. No differences in albumin clearance were apparent in intestine, kidney and heart tissue of diabetic rats compared with that of control rats. An intravenous administration of recombinant soluble RAGE (1 mg/Kg body weight) 1 hour prior to the clearance measurement shows some effect on reducing albumin clearance rates in visceral fat in early phase diabetes. Similar results were obtained for tissue extravascular water content per gram of dry weight (Figures 14A-C). Although not shown there were also indications that recombinant soluble RAGE reduced capillary pressure in diabetic rats.

D. Single Microvessel Studies

Normal rats were anesthetized with 1% and the ileal mesentery was exposed through a midline incision. The exposed gut was continuously superfused with mammalian Ringer's solution. Experiments were performed by cannulating a test vessel with control solution (5 mg/ml BSA and washed RBCs from normal rats or from diabetic rats in Ringer's solution) in the absence or presence of recombinant soluble RAGE, and examining the vessel for sticking red blood cells under a microscope. Examples of these vessels are shown in Figures 15A and 15B. Diabetic RBCs adhered to the venular wall when perfused into a normal rat vessel, whereas normal RBCs did not. Subsequent perfusion of diabetic RBCs and recombinant soluble RAGE into the same vessel did not result in further sticking of diabetic RBCs to the vessel wall. Perfusion of diabetic RBCs pretreated with recombinant soluble RAGE into the vessel from the same animal used previously did not result in adherence of RBCs to the vessel wall. Subsequent perfusion of diabetic RBCs (not pretreated with RAGE) did not result in adherence of the RBCs to the vessel wall.

While the foregoing invention has been described in some detail for purposes of clarity and understanding, it will be clear to one skilled in the art from a reading of this disclosure that various changes in form and detail can be made without departing from the true scope of the invention. All publications and patent documents cited in this application are incorporated by reference in their entirety for

all purposes to the same extent as if each individual publication or patent document were so individually denoted.

SEQUENCE LISTING

INFORMATION FOR SEQ ID NO:1:

5 (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 1023 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: double
- (D) TOPOLOGY: linear

10

(ii) MOLECULE TYPE: DNA (genomic)

15

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:1:

ATGGCAGCCG	GAACAGCA GT TGGAGCCTGG	GTGCTGGTCC	TCAGTCTGTG	GGGGGCAGTA	60
20 TAGGTGCTC	AAAACATCAC AGCCCGGATT	GGCGAGCCAC	TGGTGTGAA	GTGTAAGGGG	120
GCCCCCAAGA	AACCACCCCA GCGGCTGGAA	TGGAAACTGA	ACACAGGCCG	GACAGAACGCT	180
25 TGGAAAGGTCC	TGTCTCCCCA GGGAGGGAGGC	CCCTGGGACA	GTGTGGCTCG	TGTCCCTCCC	240
AACGGCTCCC	TCTTCCTTCC GGCTGTCGGG	ATCCAGGATG	AGGGGATTTT	CCGGTGCCAG	300
GCAATGAACA	GGAATGGAAA GGAGACCAAG	TCCA ACTACC	GAGTCCGTGT	CTACCAGATT	360
30 CCTGGGAAGC	CAGAAATTGT AGATTCTGCC	TCTGA ACTCA	CGGCTGGTGT	TCCCAATAAG	420
GTGGGGACAT	GTGTGTCA GA GGGAGCTAC	CCTGCAGGGA	CTCTTAGCTG	GCAC TTGGAT	480
35 GGGAAAGCCCC	TGGTGCCTAA TGAGAAGGGA	GTATCTGTGA	AGGAACAGAC	CAGGAGACAC	540
CCTGAGACAG	GGCTCTTCAC ACTGCAGTCG	GAGCTAATGG	TGACCCCAGC	CCGGGGAGGA	600
GATCCCCGTC	CCACCTTCTC CTGTAGCTTC	AGCCCAGGCC	TTCCCCGACA	CCGGGCCTTG	660
40 CGCACAGCCC	CCATCCAGCC CCGTGTCTGG	GAGCCTGTGC	CTCTGGAGGA	GGTCCAATTG	720
GTGGTGGAGC	CAGAAGGTGG AGCAGTAGCT	CCTGGTGGAA	CCGTAACCCCT	GACCTGTGAA	780
45 GTCCCTGCC	AGCCCTCTCC TCAAATCCAC	TGGATGAAGG	ATGGTGTGCC	CTTGCCCCTT	840
CCCCCCAGCC	CTGTGCTGAT CCTCCCTGAG	ATAGGGCCTC	AGGACCAGGG	AACCTACAGC	900
TGTGTGGCCA	CCCATTCCAG CCACGGGCC	CAGGAAAGCC	GTGCTGTCA	CATCAGCATC	960
50 ATCGAACCAAG	GCGAGGAGGG GCCAACTGCA	GGCTCTGTGG	GAGGATCAGG	GCTGGGAAC	1020
TGA					1023

40

INFORMATION FOR SEQ ID NO:2:

(i) SEQUENCE CHARACTERISTICS:

- 5 (A) LENGTH: 340 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

10 (ii) MOLECULE TYPE: peptide

15 (xi) SEQUENCE DESCRIPTION: SEQ ID NO:2:

	Met Ala Ala Gly Thr Ala Val Gly Ala Trp Val Leu Val Leu Ser Leu			
1	5	10	15	
	Trp Gly Ala Val Val Gly Ala Gln Asn Ile Thr Ala Arg Ile Gly Glu			
20	20	25	30	
	Pro Leu Val Leu Lys Cys Lys Gly Ala Pro Lys Lys Pro Pro Gln Arg			
	35	40	45	
25	Leu Glu Trp Lys Leu Asn Thr Gly Arg Thr Glu Ala Trp Lys Val Leu			
	50	55	60	
	Ser Pro Gln Gly Gly Pro Trp Asp Ser Val Ala Arg Val Leu Pro			
30	65	70	75	80
	Asn Gly Ser Leu Phe Leu Pro Ala Val Gly Ile Gln Asp Glu Gly Ile			
	85	90	95	
35	Phe Arg Cys Gln Ala Met Asn Arg Asn Gly Lys Glu Thr Lys Ser Asn			
	100	105	110	
	Tyr Arg Val Arg Val Tyr Gln Ile Pro Gly Lys Pro Glu Ile Val Asp			
	115	120	125	
40	Ser Ala Ser Glu Leu Thr Ala Gly Val Pro Asn Lys Val Gly Thr Cys			
	130	135	140	
	Val Ser Glu Gly Ser Tyr Pro Ala Gly Thr Leu Ser Trp His Leu Asp			
45	145	150	155	160
	Gly Lys Pro Leu Val Pro Asn Glu Lys Gly Val Ser Val Lys Glu Gln			
	165	170	175	
50	Thr Arg Arg His Pro Glu Thr Gly Leu Phe Thr Leu Gln Ser Glu Leu			
	180	185	190	
	Met Val Thr Pro Ala Arg Gly Gly Asp Pro Arg Pro Thr Phe Ser Cys			
	195	200	205	

55

41

	Ser Phe Ser Pro Gly Leu Pro Arg His Arg Ala Leu Arg Thr Ala Pro	
210	215	220
5	Ile Gln Pro Arg Val Trp Glu Pro Val Pro Leu Glu Glu Val Gln Leu	
225	230	235 240
	Val Val Glu Pro Glu Gly Gly Ala Val Ala Pro Gly Gly Thr Val Thr	
	245	250 255
10	Leu Thr Cys Glu Val Pro Ala Gln Pro Ser Pro Gln Ile His Trp Met	
	260	265 270
	Lys Asp Gly Val Pro Leu Pro Leu Pro Pro Ser Pro Val Leu Ile Leu	
15	275	280 285
	Pro Glu Ile Gly Pro Gln Asp Gln Gly Thr Tyr Ser Cys Val Ala Thr	
	290	295 300
20	His Ser Ser His Gly Pro Gln Glu Ser Arg Ala Val Ser Ile Ser Ile	
	305	310 315 320
	Ile Glu Pro Gly Glu Gly Pro Thr Ala Gly Ser Val Gly Gly Ser	
	325	330 335
25	Gly Leu Gly Thr	
	340	

30 INFORMATION FOR SEQ ID NO:3:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 957 base pairs

(B) TYPE: nucleic acid

35 (C) STRANDEDNESS: double

(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

40

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:3:

45	GCTCAAAACA TCACAGCCCG GATTGGCGAG CCACTGGTGC TGAAGTGTAA GGGGGCCCCC	60
	AAGAAAACCAC CCCAGCGGCT GGAATGGAAA CTGAACACAG GCCGGACAGA AGCTTGGAAAG	120
50	GTCCTGTCTC CCCAGGGAGG AGGCCCTGG GACAGTGTGG CTCGTGTCTT TCCCAACGGC	180
	TCCCTCTTCC TTCCCCCTGT CGGGATCCAG GATGAGGGGA TTTTCCGGTG CCAGGCAATG	240
	AACAGGAATG GAAAGGAGAC CAAGTCCAAC TACCGAGTCC GTGTCTACCA GATTCTGGG	300
55	AAGCCAGAAA TTGTAGATTC TGCCTCTGAA CTCACGGCTG GTGTTCCCAA TAAGGTGGGG	360

42

	ACATGTGTGT CAGAGGGAAG CTACCCCTGCA GGGACTCTTA GCTGGCACCT GGATGGGAAG	420
5	CCCCCTGGTGC CTAATGAGAA GGGAGTATCT GTGAAGGAAC AGACCAGGAG ACACCCCTGAG	480
	ACAGGGCTCT TCACACTGCA GTCGGAGCTA ATGGTGACCC CAGCCCCGGGG AGGAGATCCC	540
	CGTCCCACCT TCTCCTGTAG CTTCAGCCCCA GGCCCTTCCCC GACACCGGGC CTTGCGCACA	600
10	GCCCCCATCC AGCCCCGTGT CTGGGAGCCT GTGCCTCTGG AGGAGGTCCA ATTGGTGGTG	660
	GAGCCAGAAG GTGGAGCAGT AGCTCCTGGT GGAACCGTAA CCCTGACCTG TGAAGTCCCT	720
	GCCCAGCCCT CTCCTCAAAT CCACTGGATG AAGGATGGTG TGCCCTTGCC CCTTCCCCCC	780
15	AGCCCTGTGC TGATCCTCCC TGAGATAGGG CCTCAGGACC AGGGAACCTA CAGCTGTGTG	840
	GCCACCCATT CCAGCCACGG GCCCCAGGAA AGCCGTGCTG TCAGCATCAG CATCATCGAA	900
20	CCAGGCGAGG AGGGGCCAAC TGCAGGCTCT GTGGGAGGAT CAGGGCTGGG AACTTGA	957

INFORMATION FOR SEQ ID NO:4:

25 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 318 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

30 (ii) MOLECULE TYPE: peptide

35

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:4:

40	Ala Gln Asn Ile Thr Ala Arg Ile Gly Glu Pro Leu Val Leu Lys Cys 1 5 10 15
	Lys Gly Ala Pro Lys Lys Pro Pro Gln Arg Leu Glu Trp Lys Leu Asn 20 25 30
45	Thr Gly Arg Thr Glu Ala Trp Lys Val Leu Ser Pro Gln Gly Gly Gly 35 40 45
	Pro Trp Asp Ser Val Ala Arg Val Leu Pro Asn Gly Ser Leu Phe Leu 50 55 60
50	Pro Ala Val Gly Ile Gln Asp Glu Gly Ile Phe Arg Cys Gln Ala Met 65 70 75 80
	Asn Arg Asn Gly Lys Glu Thr Lys Ser Asn Tyr Arg Val Arg Val Tyr 85 90 95

Gln Ile Pro Gly Lys Pro Glu Ile Val Asp Ser Ala Ser Glu Leu Thr
 100 105 110

5 Ala Gly Val Pro Asn Lys Val Gly Thr Cys Val Ser Glu Gly Ser Tyr
 115 120 125

Pro Ala Gly Thr Leu Ser Trp His Leu Asp Gly Lys Pro Leu Val Pro
 130 135 140

10 Asn Glu Lys Gly Val Ser Val Lys Glu Gln Thr Arg Arg His Pro Glu
 145 150 155 160

Thr Gly Leu Phe Thr Leu Gln Ser Glu Leu Met Val Thr Pro Ala Arg
 165 170 175

Gly Gly Asp Pro Arg Pro Thr Phe Ser Cys Ser Phe Ser Pro Gly Leu
 180 185 190

20 Pro Arg His Arg Ala Leu Arg Thr Ala Pro Ile Gln Pro Arg Val Trp
 195 200 205

Glu Pro Val Pro Leu Glu Glu Val Gln Leu Val Val Glu Pro Glu Gly
 210 215 220

25 Gly Ala Val Ala Pro Gly Gly Thr Val Thr Leu Thr Cys Glu Val Pro
 225 230 235 240

Ala Gln Pro Ser Pro Gln Ile His Trp Met Lys Asp Gly Val Pro Leu
 245 250 255

30 Pro Leu Pro Pro Ser Pro Val Leu Ile Leu Pro Glu Ile Gly Pro Gln
 260 265 270

35 Asp Gln Gly Thr Tyr Ser Cys Val Ala Thr His Ser Ser His Gly Pro
 275 280 285

Gln Glu Ser Arg Ala Val Ser Ile Ser Ile Ile Glu Pro Gly Glu Glu
 290 295 300

40 Gly Pro Thr Ala Gly Ser Val Gly Gly Ser Gly Leu Gly Thr
 305 310 315

45 INFORMATION FOR SEQ ID NO:5:

(i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 10 amino acids
 50 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

55 (ii) MOLECULE TYPE: peptide

44

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:5:

Cys Lys Gly Ala Pro Lys Lys Pro Pro Gln
1 5 10

5

INFORMATION FOR SEQ ID NO:6:

10

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 11 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

15

(ii) MOLECULE TYPE: peptide

20

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:6:

Trp Lys Leu Asn Thr Gly Arg Thr Glu Ala Cys
25 1 5 10

30

INFORMATION FOR SEQ ID NO:7:

35

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 10 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

40

(ii) MOLECULE TYPE: peptide

45

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:7:

Gly Pro Gln Asp Gln Gly Thr Tyr Ser Cys
1 5 10

50

45

INFORMATION FOR SEQ ID NO:8:

- 5 (i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 10 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

10

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:8:

15 Trp Lys Leu Asn Thr Gly Arg Thr Glu Ala
 1 5 10

- 25 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 11 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

30 (ii) MOLECULE TYPE: peptide

35 (xi) SEQUENCE DESCRIPTION: SEQ ID NO:9:

Cys Glu Val Pro Ala Gln Pro Ser Pro Gln Ile
1 5 10

40

INFORMATION FOR SEQ ID NO:10:

- 45 (i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 14 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

46

(ii) MOLECULE TYPE: peptide

5

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:10:

Cys Arg Ala Met Asn Gln Asn Gly Lys Glu Thr Lys Ser Asn
1 5 10

INFORMATION FOR SEQ ID NO:11:

15

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 10 amino acids
 - (B) TYPE: amino acid
 - (C) STRANDEDNESS: single
 - (D) TOPOLOGY: linear

20

(ii) MOLECULE TYPE: peptide

25

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:11:

30

Gly Pro Gln Asp Gln Gly Thr Tyr Ser Cys
1 5 10

35 INFORMATION FOR SEQ ID NO:12:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 15 amino acids
 - (B) TYPE: amino acid
 - (C) STRANDEDNESS: single
 - (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

45

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:12:

50

Ala Gln Asn Ile Thr Ala Arg Ile Gly Glu Pro Leu Val Leu Lys
1 5 10 15

47

INFORMATION FOR SEQ ID NO:13:

- 5 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 10 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear
- 10 (ii) MOLECULE TYPE: peptide

15 (xii) SEQUENCE DESCRIPTION: SEQ ID NO:13:

Cys Lys Gly Ala Pro Lys Lys Pro Pro Gln
1 5 10

20

INFORMATION FOR SEQ ID NO:14:

- 25 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 9 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear
- 30 (ii) MOLECULE TYPE: peptide

35 (xiii) SEQUENCE DESCRIPTION: SEQ ID NO:14:

Glu Gln Thr Arg Arg His Pro Glu Thr
1 5

40

INFORMATION FOR SEQ ID NO:15:

- 45 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 11 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear
- 50 (ii) MOLECULE TYPE: peptide

48

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:15:

Arg Gly Gly Asp Pro Arg Pro Thr Phe Ser Cys
1 5 10

5

INFORMATION FOR SEQ ID NO:16:

10

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 10 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

15

(ii) MOLECULE TYPE: peptide

20

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:16:

Ser Pro Gly Leu Pro Arg His Arg Ala Leu
25 1 5 10

30 INFORMATION FOR SEQ ID NO:17:

- (i) SEQUENCE CHARACTERISTICS:
- (A) LENGTH: 10 amino acids
 - (B) TYPE: amino acid
 - (C) STRANDEDNESS: single
 - (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

40

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:17:

Ser Ser His Gly Pro Gln Glu Ser Arg Ala
45 1 5 10

50

49

INFORMATION FOR SEQ ID NO:18:

(i) SEQUENCE CHARACTERISTICS:

- 5 (A) LENGTH: 16 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

10

15

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:18:

Ala Gln Asn Ile Thr Ala Arg Ile Gly Glu Pro Leu Val Leu Lys Cys
1 5 10 15

20

INFORMATION FOR SEQ ID NO:19:

25 (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 10 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

30

(ii) MOLECULE TYPE: peptide

35

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:19:

Cys Glu Gln Thr Arg Arg His Pro Glu Thr
1 5 10

40

45

50

50

INFORMATION FOR SEQ ID NO:20:

(i) SEQUENCE CHARACTERISTICS:

- 5 (A) LENGTH: 11 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

10

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:20:

15

Cys Ser Pro Gly Leu Pro Arg His Arg Ala Leu
1 5 10

20

INFORMATION FOR SEQ ID NO:21:

(i) SEQUENCE CHARACTERISTICS:

- 25 (A) LENGTH: 11 amino acids
 (B) TYPE: amino acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

30 (ii) MOLECULE TYPE: peptide

35 (xi) SEQUENCE DESCRIPTION: SEQ ID NO:21:

Ser Ser His Gly Pro Gln Glu Ser Arg Ala Cys
1 5 10

40

45

50

INFORMATION FOR SEQ ID NO:22:

- 5 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 22 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

10 (ii) MOLECULE TYPE: DNA (genomic)

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:22:

15 GATGGCAGCC GGAACAGCAG TT

22

20 INFORMATION FOR SEQ ID NO:23:

- 25 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 24 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

30

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:23:

35 CTCAAGTTCC CAGCCCTGAT CCTC

24



American Type Culture Collection

12301 Parklawn Drive • Rockville, MD 20852 USA • Telephone: (301) 231-5520 Telex: 908-768 ATCCROVE • FAX: 301-816-4346

BUDAPEST TREATY ON THE INTERNATIONAL RECOGNITION OF THE DEPOSIT OF MICROORGANISMS FOR THE PURPOSES OF PATENT PROCEDURE

INTERNATIONAL FORM

RECEIPT IN THE CASE OF AN ORIGINAL DEPOSIT ISSUED PURSUANT TO RULE 7.3 AND VIABILITY STATEMENT ISSUED PURSUANT TO RULE 10.2

To: (Name and Address of Depositor or Attorney)

Berlex Biosciences
Attn: Mariko Nagashima
15049 San Pablo Avenue
Richmond, CA 94804

Deposited on Behalf of: Berlex Biosciences, a division of Berlex Laboratories, Inc.

Identification Reference by Depositor: ATCC Designation

AcMNPV Baculovirus RAGE 23-1	VR-2538
AcMNPV Baculovirus RAGE 11B	VR-2539

The deposits were accompanied by: _____ a scientific description _____ a proposed taxonomic description indicated above.

The deposits were received July 10, 1996 by this International Depository Authority and have been accepted.

AT YOUR REQUEST:

We will inform you of requests for the strains for 30 years.

The strains will be made available if a patent office signatory to the Budapest Treaty certifies one's right to receive, or if a U.S. Patent is issued citing the strains, and ATCC is instructed by the United States Patent & Trademark Office or the depositor to release said strains.

If the cultures should die or be destroyed during the effective term of the deposit, it shall be your responsibility to replace them with living cultures of the same.

The strains will be maintained for a period of at least 30 years from date of deposit, or five years after the most recent request for a sample, whichever is longer. The United States and many other countries are signatory to the Budapest Treaty.

The viability of the cultures cited above was tested July 29, 1996. On that date, the cultures were viable.

International Depository Authority: American Type Culture Collection, Rockville, Md. 20852 USA

Signature of person having authority to represent ATCC:

Barbara M. Hailey

Barbara M. Hailey, Administrator, Patent Depository

Date: August 6, 1996

✓cc: Carol J. Roth



American Type Culture Collection

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**BUDAPEST TREATY ON THE INTERNATIONAL RECOGNITION OF
THE DEPOSIT OF MICROORGANISMS FOR THE PURPOSES OF PATENT PROCEDURE**

INTERNATIONAL FORM

**RECEIPT IN THE CASE OF AN ORIGINAL DEPOSIT ISSUED PURSUANT TO RULE 7.3
AND VIABILITY STATEMENT ISSUED PURSUANT TO RULE 10.2**

To: (Name and Address of Depositor or Attorney)

Berlex Biosciences
Attn: Doris A. Hollander
15049 San Pablo Avenue
Richmond, CA 94804-0099

Deposited on Behalf of: Berlex Biosciences

Identification Reference by Depositor:

ATCC Designation

Hybridoma cell line, mouse x mouse, SW 10C1
Hybridoma cell line, mouse x mouse, RBF 9D9
Hybridoma cell line, mouse x mouse, SW1E8

HB-12164
HB-12165
HB-12166

The deposits were accompanied by: a scientific description a proposed taxonomic description indicated above.

The deposits were received August 6, 1996 by this International Depository Authority and have been accepted.

AT YOUR REQUEST:

We will inform you of requests for the strains for 30 years.

The strains will be made available if a patent office signatory to the Budapest Treaty certifies one's right to receive, or if a U.S. Patent is issued citing the strains, and ATCC is instructed by the United States Patent & Trademark Office or the depositor to release said strains.

If the cultures should die or be destroyed during the effective term of the deposit, it shall be your responsibility to replace them with living cultures of the same.

The strains will be maintained for a period of at least 30 years from date of deposit, or five years after the most recent request for a sample, whichever is longer. The United States and many other countries are signatory to the Budapest Treaty.

The viability of the cultures cited above was tested August 9, 1996. On that date, the cultures were viable.

International Depository Authority: American Type Culture Collection, Rockville, Md. 20852 USA

Signature of person having authority to represent ATCC:

Barbara M. Hailey
Barbara M. Hailey, Administrator, Patent Depository

Date: August 9, 1996

✓cc: Carol J. Roth

Claims

54

1. An isolated antibody, said antibody being specifically immunoactive with a soluble human receptor to an advanced glycosylation end-product ("RAGE") polypeptide.
2. The isolated antibody of claim 1, wherein said antibody is specifically immunoreactive with a polypeptide having an amino acid sequence substantially homologous to the amino acid sequence shown in Figures 1A or 1B (Seq ID NOS: 2 and 4), or immunologically active fragments thereof.
3. The isolated antibody of claim 2, wherein said antibody is specifically immunoreactive with a polypeptide having an amino acid sequence shown in Figure 1B (Seq ID NO: 4).
4. The isolated antibody of claim 1, wherein said antibody is monoclonal.
5. The isolated antibody of claim 1, wherein said antibody is selected from the group consisting of RBF9D9 (ATCC Accession No. HB-12165), SW10C1 (ATCC Accession No. HB-12164) and SW1E8 (ATCC Accession No. HB-12166).
6. The isolated antibody of claim 1, wherein said antibody is polyclonal.
7. The isolated antibody of claim 1, wherein said antibody is humanized.
8. The isolated antibody of claim 1, wherein said antibody further comprises a labeling group.
9. The isolated antibody of claim 8, wherein said labeling group is selected from the group consisting of a fluorescent label, a radioactive label and a bioactive label.

10. An isolated antibody, said antibody being capable of inhibiting an interaction between an advanced glycosylation end-product ("AGE") and its receptor.
- 5 11. The isolated antibody of claim 10, wherein said antibody is specifically immunoreactive with a soluble human RAGE polypeptide.
- 10 12. The isolated antibody of claim 11, wherein said human RAGE polypeptide is a soluble human RAGE polypeptide having an amino acid sequence shown in Figure 1A or 1B (Seq ID NOS: 2 and 4), or immunologically active fragments thereof.
- 15 13. A pharmaceutical composition, comprising an antibody that is specifically immunoreactive with a soluble human RAGE polypeptide in combination with a pharmaceutically acceptable carrier.
- 20 14. The pharmaceutical composition of claim 13, wherein said antibody inhibits an interaction between an AGE protein and a human RAGE polypeptide.
- 25 15. The pharmaceutical composition of claim 13, wherein said antibody is specifically immunoreactive with a polypeptide having an amino acid sequence substantially homologous to the amino acid sequence shown in Figure 1A or 1B (Seq ID NOS: 2 and 4), or immunologically active fragments thereof.
- 30 16. The pharmaceutical composition of claim 13, wherein said antibody is specifically immunoreactive with a polypeptide having an amino acid sequence substantially homologous to the amino acid sequence shown in Figure 1A or 1B (Seq ID NOS: 2 and 4).
- 35 17. A method of treating a patient for symptoms of a disorder, wherein said symptoms are caused by an interaction between an AGE and its receptor, the method comprising administering to said patient an effective amount of an antibody that is specifically immunoreactive with a soluble human RAGE polypeptide.
18. The method of claim 17, wherein said patient is a diabetic patient, and said symptom is increased vascular permeability.

19. The method of claim 17, wherein said disorder is Diabetes Mellitus and said symptom is selected from the group consisting of diabetic microvasculopathy, diabetic macrovasculopathy and occlusive vascular disorder.

5 20. The method of claim 19, wherein said symptom is selected from the group consisting of neuropathy, nephropathy, retinopathy and atherosclerosis.

21. A method of detecting a human RAGE polypeptide in a sample, the method comprising the steps of:

10 contacting the sample with an isolated antibody that is specifically immunoreactive with a soluble human RAGE polypeptide; and determining whether the antibody specifically immunoreacts with a component of the sample.

15 22. A method of purifying a human RAGE polypeptide from a mixture of proteins, the method comprising the steps of:

providing an antibody that is specifically immunoreactive with a soluble human RAGE polypeptide immobilized on a solid support; contacting the solid support with the mixture of proteins under conditions permitting a specific immunoreaction between the antibody and the human RAGE polypeptide from the mixture of proteins; removing nonspecifically bound proteins from said solid support; and isolating the human RAGE polypeptide from the solid support in substantially pure form.

25 23. Use of an effective amount of an antibody that is specifically immunoreactive with a soluble human RAGE polypeptide for the production of a pharmaceutical compound or composition for the treatment of a patient for symptoms of a disorder, wherein said symptoms are caused by an interaction between an AGE and its receptor.

30 24. Use according to claim 23, wherein said patient is a diabetic patient, and said symptom is increased vascular permeability.

35 25. Use according to claim 23, wherein said disorder is Diabetes Mellitus and said symptom is selected from the group consisting of diabetic microvasculopathy, diabetic macrovasculopathy and occlusive vascular disorder.

26. Use according to claim 25, wherein said symptom is selected from the group consisting of neuropathy, nephropathy, retinopathy and atherosclerosis.
- 5 27. Use according to claim 23, wherein said symptom is hemodialysis-associated amyloidosis.

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1 MetAlaAlaGlyThrAlaValGlyAlaTrpValLeuValLeuSerLeuTrpGlyAlaVal
 2 1 ATGGCAGCCGGAACAGCAGTTGGAGCCTGGGTGCTGGTCCTCAGTCTGTGGGGGGCAGTA
 3
 4 ValGlyAlaGlnAsnIleThrAlaArgIleGlyGluProLeuValLeuLysCysLysGly
 5 61 GTAGGTGCTCAAAACATCACAGCCCCGATTGGCGAGCCACTGGTGCTGAAGTGTAAAGGG
 6
 7 AlaProLysLysProProGlnArgLeuGluTrpLysLeuAsnThrGlyArgThrGluAla
 8 121 GCCCCCAAGAAACCACCCCAGCGGCTGGAATGAAACTGAACACAGGCCGACAGAAGCT
 9
 10 TrpLysValLeuSerProGlnGlyGlyProTrpAspSerValAlaArgValLeuPro
 11 181 TGGAAAGGTCTGTCTCCCCAGGGAGGCCCCCTGGGACAGTGTGGCTCGTGCCTTCCC
 12
 13 AsnGlySerLeuPheLeuProAlaValGlyIleGlnAspGluGlyIlePheArgCysGln
 14 241 AACGGCTCCCTCTCCTCCGGCTGTCGGATCCAGGATGAGGGATTTCCGGTGCCAG
 15
 16 AlaMetAsnArgAsnGlyLysGluThrLysSerAsnTyrArgValArgValTyrGlnIle
 17 301 GCAATGAAACAGGAATGGAAAAGGAGACCAAGTCAAATCACCAGTCCGTGCTACCAAGATT
 18
 19 ProGlyLysProGluIleValAspSerAlaSerGluLeuThrAlaGlyValProAsnLys
 20 361 CCTGGGAAGCCAGAAATTGTAGATTCTGCCTCTGAACTCACGGCTGGTGTCCCAATAAG
 21
 22 ValGlyThrCysValSerGluGlySerTyrProAlaGlyThrLeuSerTrpHisLeuAsp
 23 421 GTGGGGACATGTGTGTCAGAGGGAGCTACCCCTCAGGGACTCTTAGCTGGCACTGGAT
 24
 25 GlyLysProLeuValProAsnGluLysGlyValSerValLysGluGlnThrArgArgHis
 26 481 GGGAAAGCCCCCTGGTGCCTAATGAGAAGGGAGTATCTGTGAAGGAACAGACCAGGAGACAC
 27
 28 ProGluThrGlyLeuPheThrLeuGlnSerGluLeuMetValThrProAlaArgGlyGly
 29 541 CCTGAGACAGGGCTCTCACACTGCGAGCTAATGGTACCCCCAGCCCCGGGAGGA
 30
 31 AspProArgProThrPheSerCysSerPheSerProGlyLeuProArgHisArgAlaLeu
 32 601 GATCCCCGTCCCACCTCTCCTGTAGCTTCAGCCCAGGCCCTCCCCGACACGGGCTTG
 33
 34 ArgThrAlaProIleGlnProArgValTrpGluProValProLeuGluGluValGlnLeu
 35 661 CGCACAGCCCCCATCCAGCCCCGTCTGGAGCCTGTGCCTCTGGAGGAGGTCCAATTG
 36
 37 ValValGluProGluGlyGlyAlaValAlaProGlyGlyThrValThrLeuThrCysGlu
 38 721 GTGGTGGAGCCAGAGTGGAGCAGTAGCTCTGGTGGAAACGTAACCTGACCTGTGAA
 39
 40 ValProAlaGlnProSerProGlnIleHisTrpMetLysAspGlyValProLeuProLeu
 41 781 GTCCCTGCCAGCCCTCTCCTCAAATCCACTGGATGAAGGATGGTGTGCCCTTGCCCCCTT
 42
 43 ProProSerProValLeuIleLeuProGluIleGlyProGlnAspGlnGlyThrTyrSer
 44 841 CCCCCCAGCCCTGTGCTGATCCTCCCTGAGATAGGGCCTCAGGACCAGGGAACCTACAGC
 45
 46 CysValAlaThrHisSerSerHisGlyProGlnGluSerArgAlaValSerIleSerIle
 47 901 TGTGTGGCCACCCATTCCAGCCACGGGCCCCAGAAAGCCGTGTCAGCATCAGCATC
 48
 49 IleGluProGlyGluGluGlyProThrAlaGlySerValGlyGlySerGlyLeuGlyThr
 50 961 ATCGAACCCAGGGAGGGAGGGCCAACTGCAGGCTCTGGAGGATCAGGGCTGGAACT
 51
 52 OP
 53 1021 TGA

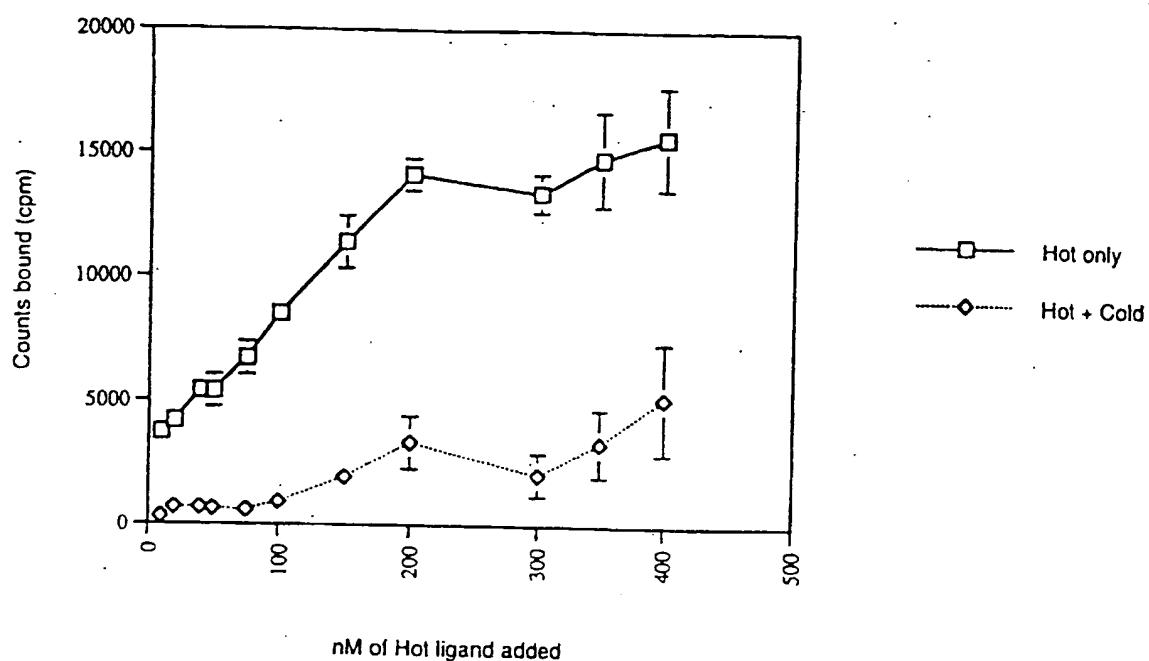
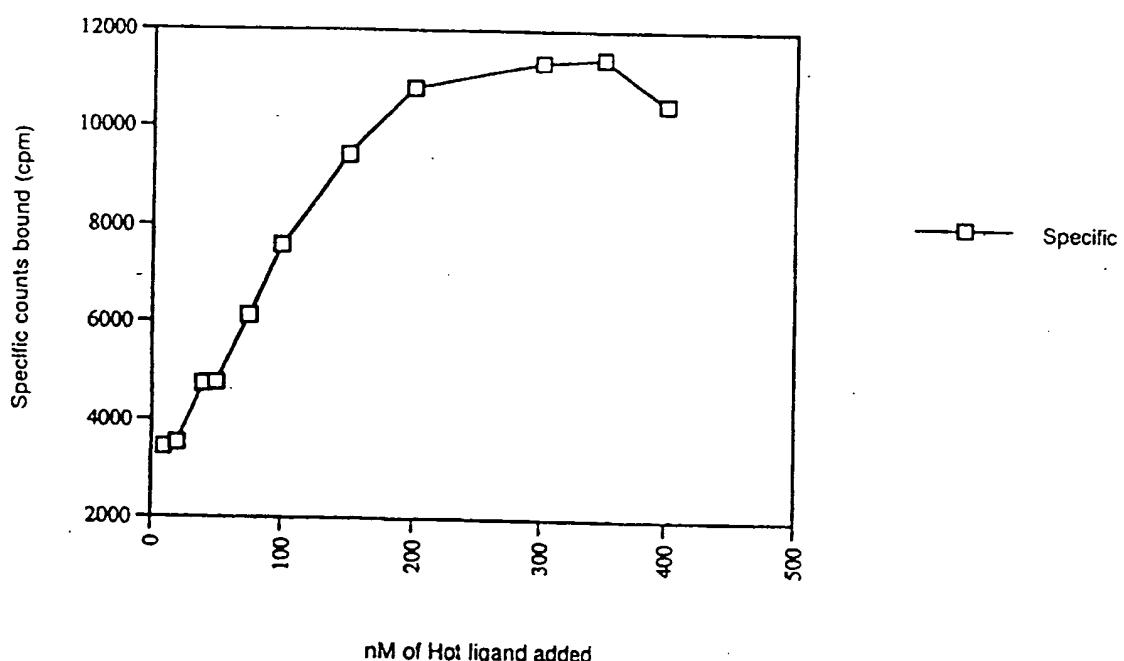
Figure 1A

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1 AlaGlnAsnIleThrAlaArgIleGlyGluProLeuValLeuLysCysLysGlyAlaPro
 2 1 GCTCAAAACATCACAGCCGGATTGGCGAGCCACTGGTGTGAAGTGTAAAGGGGGCCCC
 3
 4 LysLysProProGlnArgLeuGluTrpLysLeuAsnThrGlyArgThrGluAlaTrpLys
 5 61 AAGAAACCACCCCAGCGCTGGAATGAAACTGAACACAGGCCGGACAGAAGCTTGGAAAG
 6
 7 ValLeuSerProGlnGlyGlyGlyProTrpAspSerValAlaArgValLeuProAsnGly
 8 121 GTCCTGTCTCCCCAGGGAGGAGGCCCTGGACAGTGTGGCTGTGCCTTCCCAAACGGC
 9
 10 SerLeuPheLeuProAlaValGlyIleGlnAspGluGlyIlePheArgCysGlnAlaMet
 11 181 TCCCTCTCCTTCCGGCTGTCGGGATCCAGGATGAGGGGATTTCCGGTGCCAGGCAATG
 12
 13 AsnArgAsnGlyLysGluThrLysSerAsnTyrArgValArgValTyrGlnIleProGly
 14 241 AACAGGAATGGAAAGGAGACCAAGTCCAACCTACCGAGTCCGTCTACCAGATTCTGGG
 15
 16 LysProGluIleValAspSerAlaSerGluLeuThrAlaGlyValProAsnLysValGly
 17 301 AAGCCAGAAAATTGTAGATTCTGCCTCTGAACACTACGGCTGGTGTCCAAATAAGGTGGGG
 18
 19 ThrCysValSerGluGlySerTyrProAlaGlyThrLeuSerTrpHisLeuAspGlyLys
 20 361 ACATGTGTGTCAGAGGGAAAGCTACCCCTGCAGGGACTCTTAGCTGGCACTTGGATGGGAAG
 21
 22 ProLeuValProAsnGluLysGlyValSerValLysGluGlnThrArgArgHisProGlu
 23 421 CCCCTGGTGCCTAATGAGAAGGGAGTATCTGTGAAGGAACAGACCAGGAGACACCCTGAG
 24
 25 ThrGlyLeuPheThrLeuGlnSerGluLeuMetValThrProAlaArgGlyGlyAspPro
 26 481 ACAGGGCTTTCACACTGCAGTCGGAGCTAATGGTACCCAGCCGGGAGGAGATCCC
 27
 28 ArgProThrPheSerCysSerPheSerProGlyLeuProArgHisArgAlaLeuArgThr
 29 541 CGTCCCACCTTCTCCTGTAGCTTCAGCCCAGGCCCTCCCCGACACCGGGCCTGGCGACA
 30
 31 AlaProIleGlnProArgValTrpGluProValProLeuGluGluValGlnLeuValVal
 32 601 GCCCCCATCCAGCCCCGTCTGGAGGCCTGTGCCTCTGGAGGGAGGTCCAATTGGTGGTG
 33
 34 GluProGluGlyGlyAlaValAlaProGlyGlyThrValThrLeuThrCysGluValPro
 35 661 GAGCCAGAAGGTGGAGCAGTAGCTCTGGTAACCGTACCTGTGAAGTCCCT
 36
 37 AlaGlnProSerProGlnIleHisTrpMetLysAspGlyValProLeuProLeuProPro
 38 721 GCCCAGCCCTCTCCTCAAATCCACTGGATGAAGGATGGTGTGCCCTGCCCTCCCCCCC
 39
 40 SerProValLeuIleLeuProGluIleGlyProGlnAspGlnGlyThrTyrSerCysVal
 41 781 AGCCCTGTGCTGATCCTCCCTGAGATAGGCCTCAGGACCAGGGAACCTACAGCTGTGTG
 42
 43 AlaThrHisSerSerHisGlyProGlnGluSerArgAlaValSerIleSerIleIleGlu
 44 841 GCCACCCATTCCAGCCACGGGCCCCAGGAAAGCCGTGCTGTCAAGCATCAGCATCATCGAA
 45
 46 ProGlyGluGluGlyProThrAlaGlySerValGlyGlySerGlyLeuGlyThrOP
 47 901 CCAGGGCAGGGAGGGGCCAACTGCAGGCTCTGTGGAGGATCAGGCTGGAACTTGA

Figure 1B

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Indirect Solid-phase RAGE/AGE binding Assay**Figure 2A****Figure 2B**

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Indirect Solid-phase RAGE/AGE binding assay
RAGE dose response curve

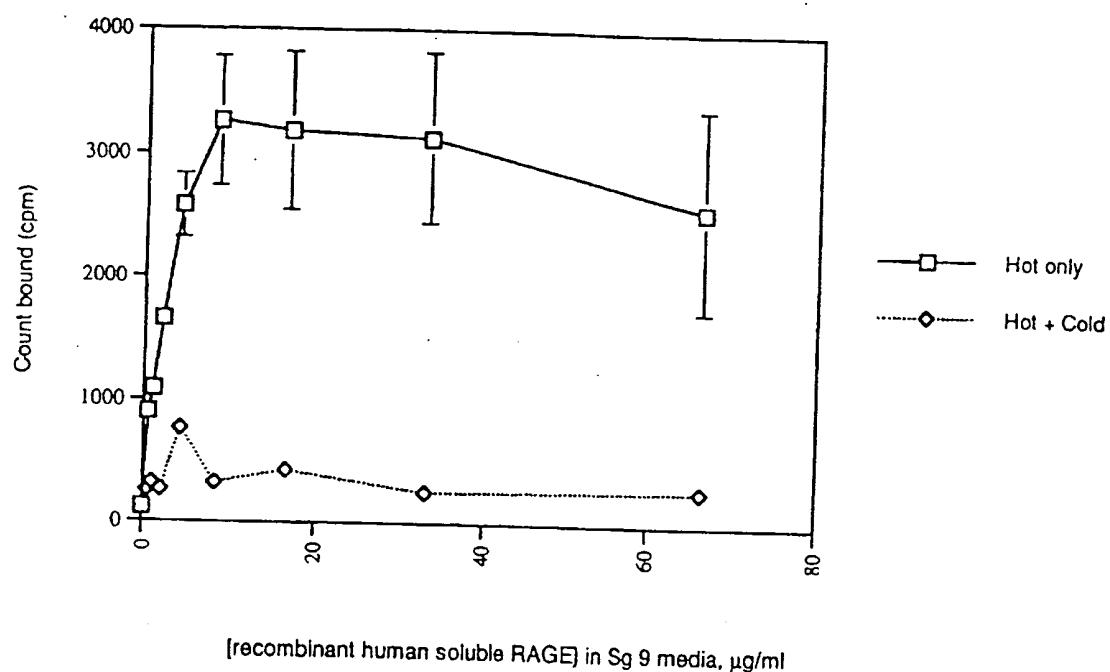
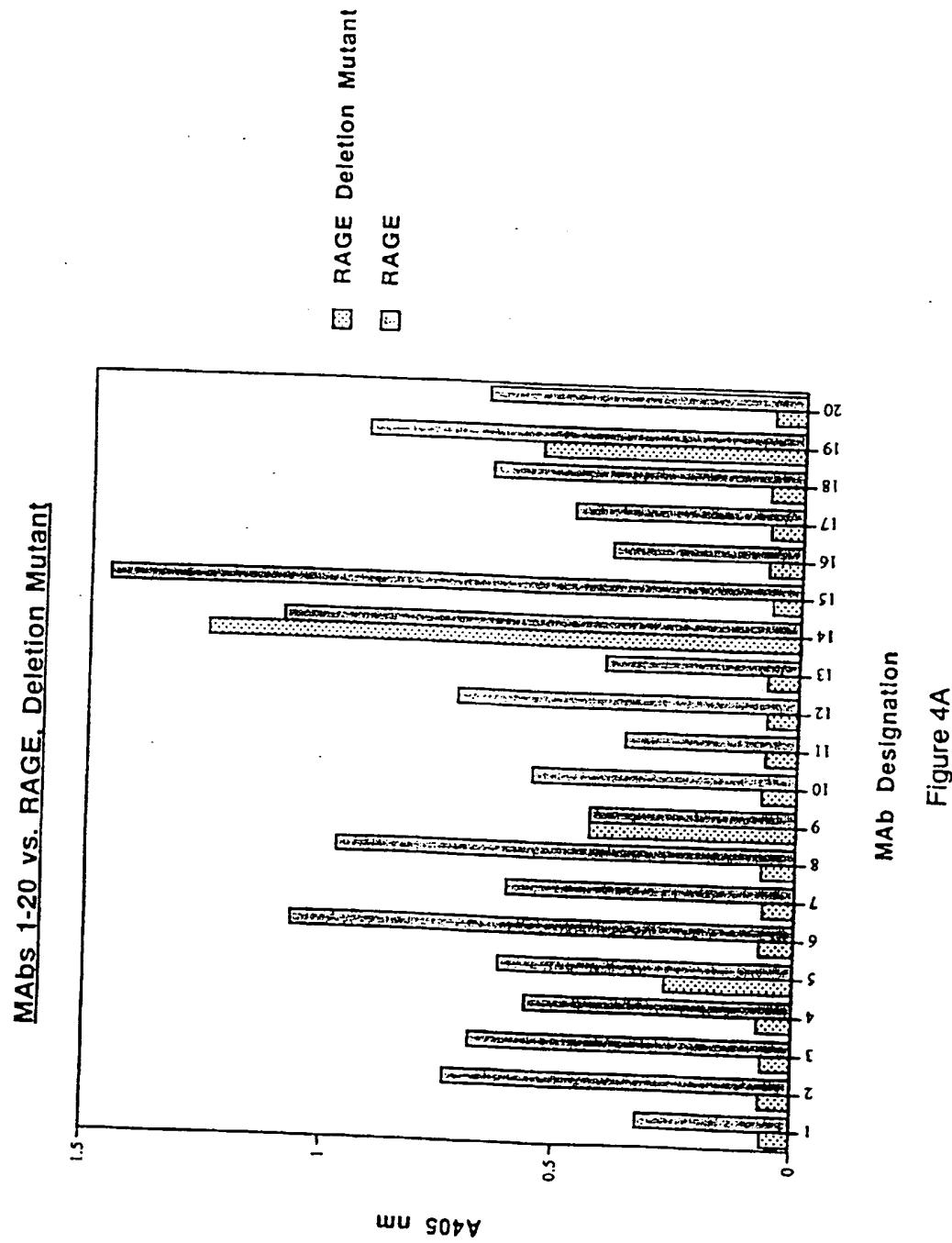
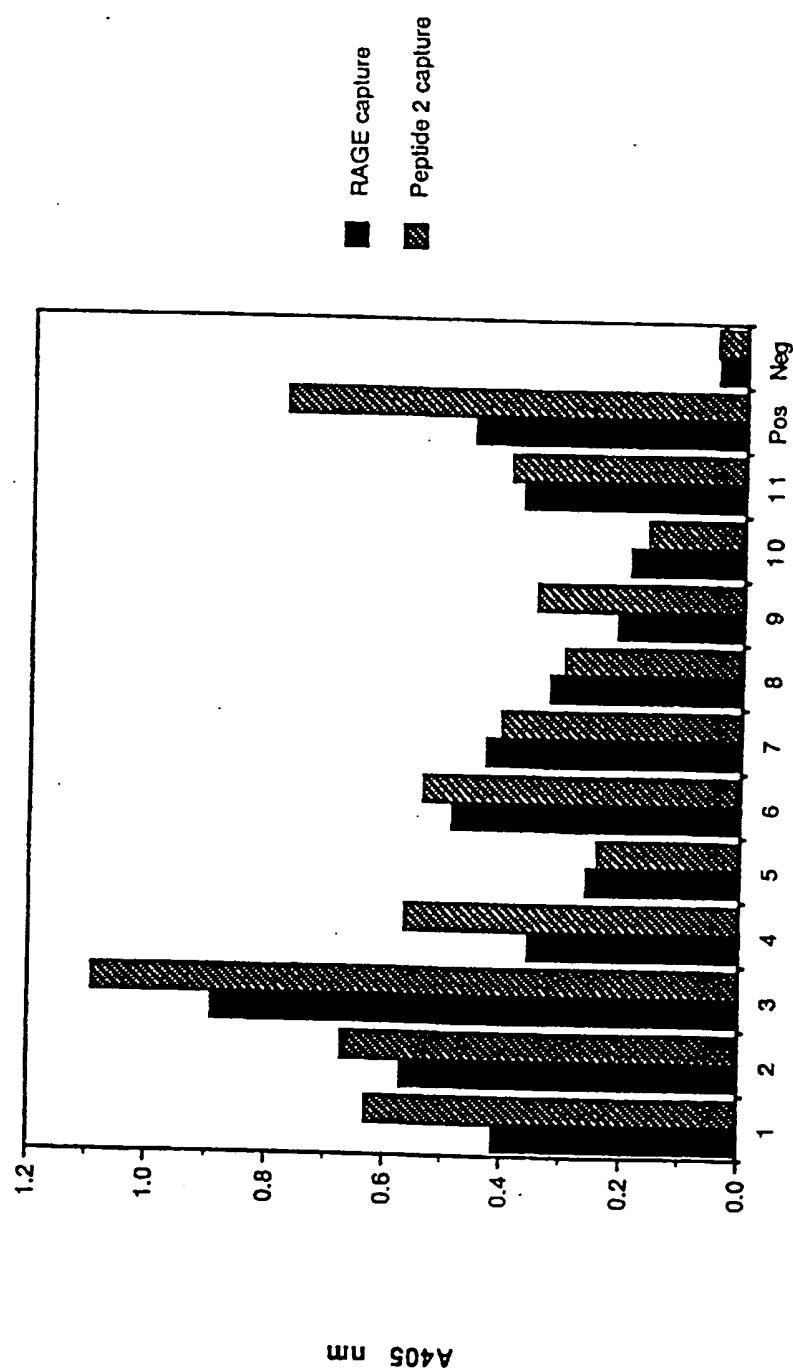


Figure 3

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Poly/MAb Antigen Capture EIA

MAb Designation
Figure 4B

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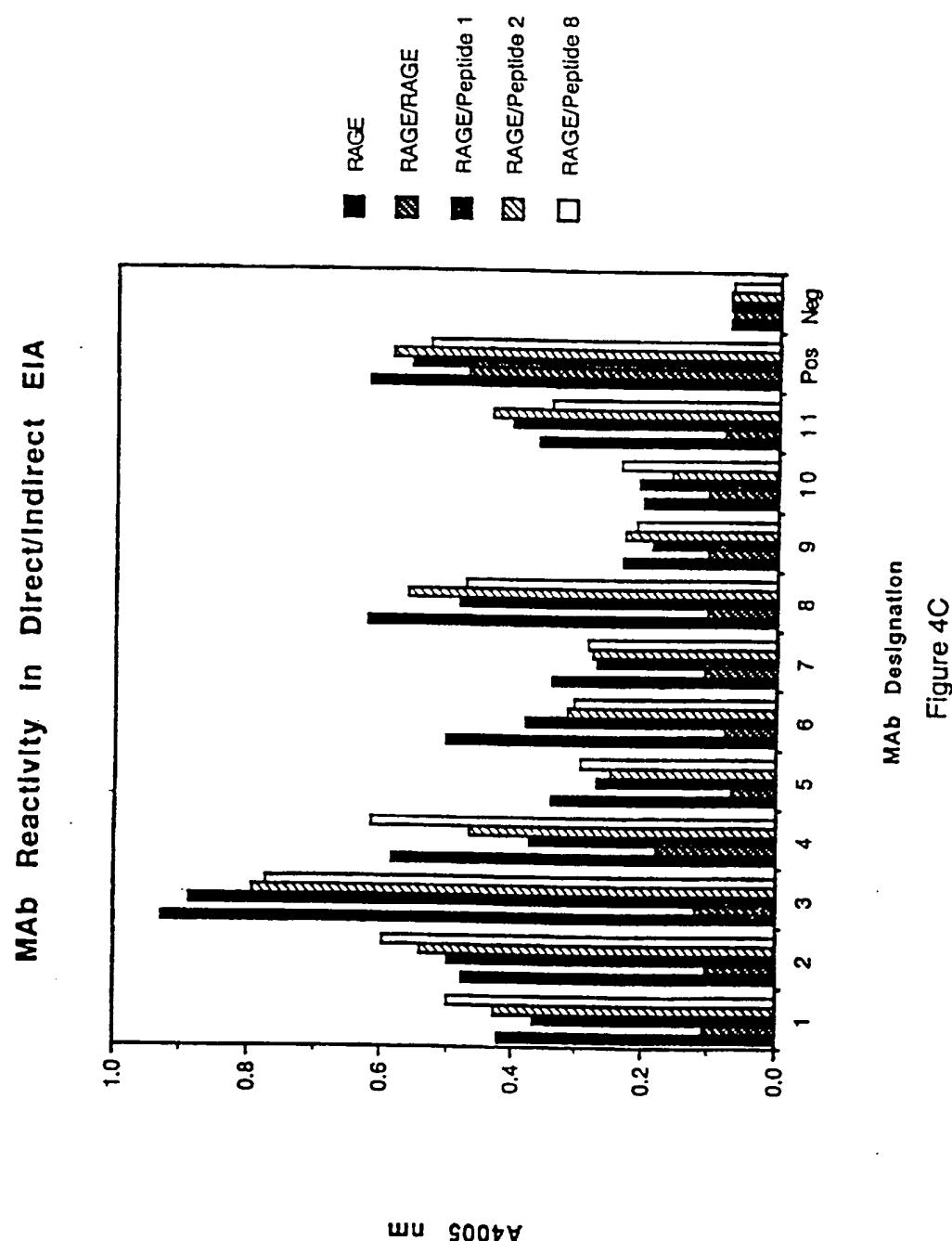


Figure 4C

A4005 nm

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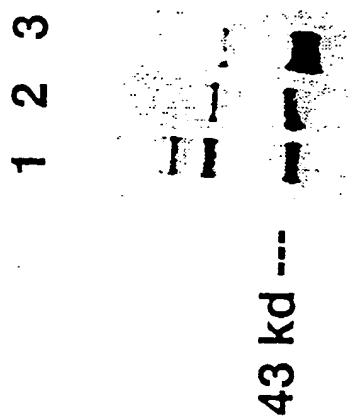
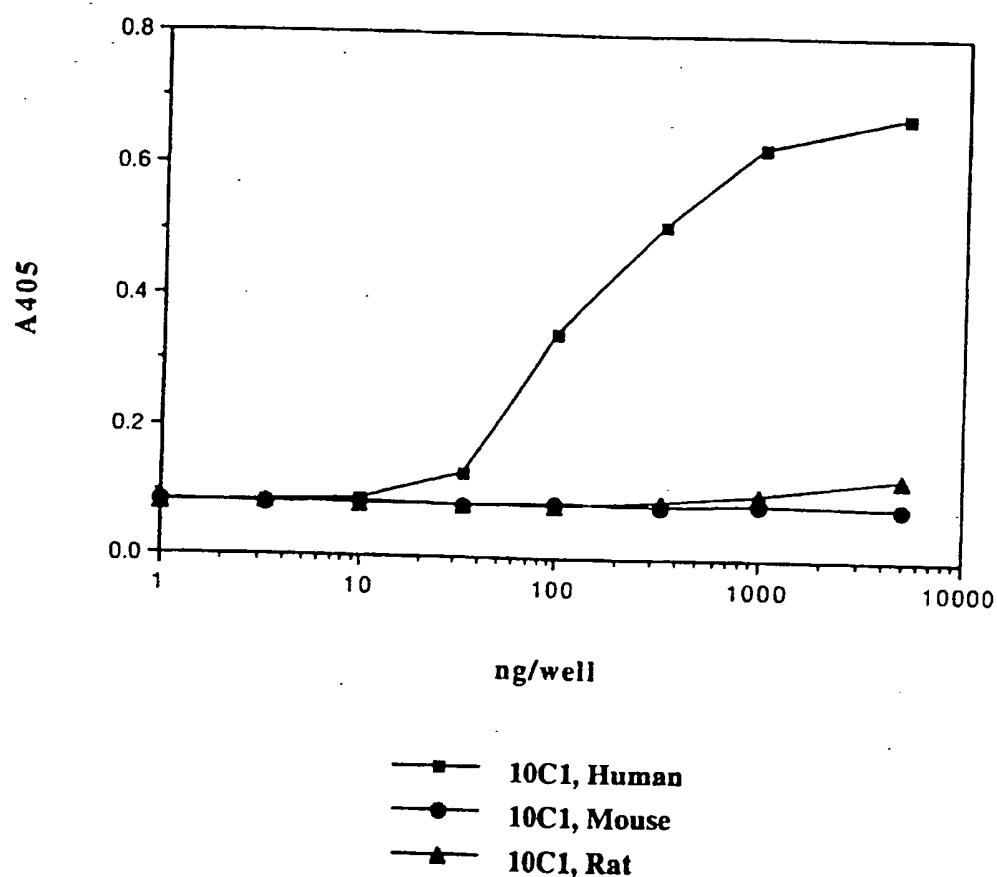


Figure 5

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Antigen Capture EIA: MAbs 9D9:10C1**Figure 6A**

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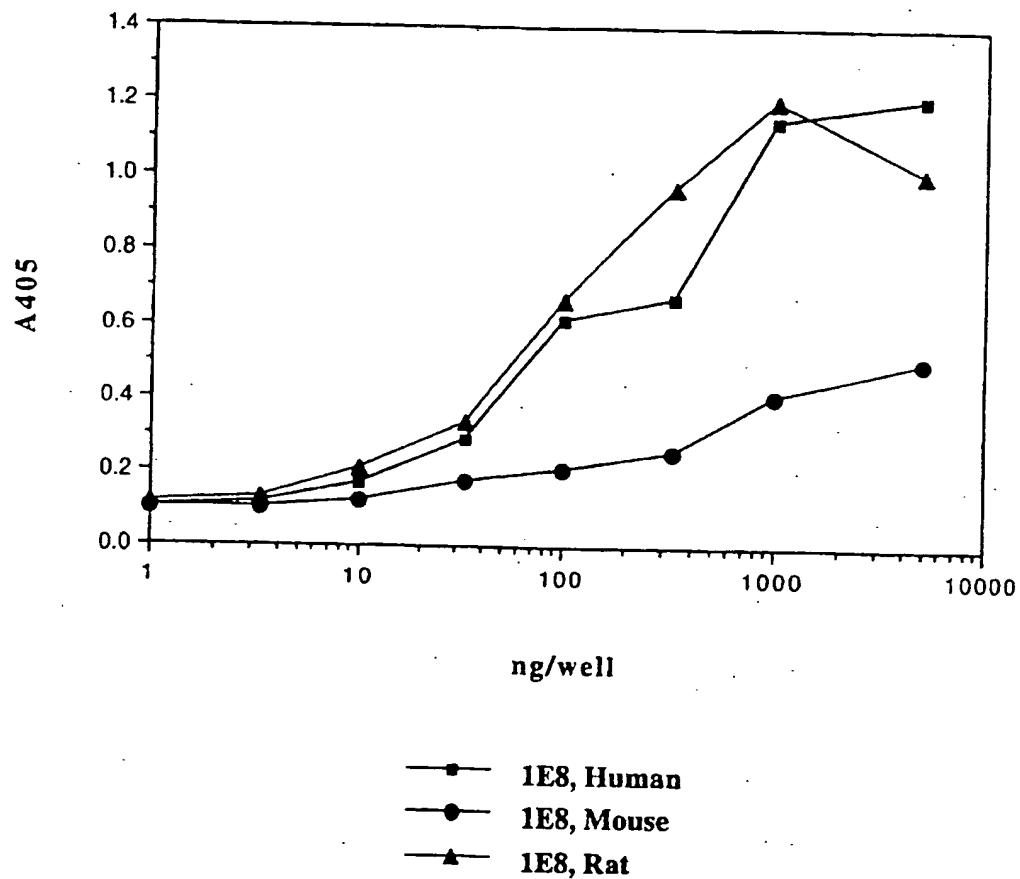
Antigen Capture EIA: MAbs 9D9:1E8

Figure 6B

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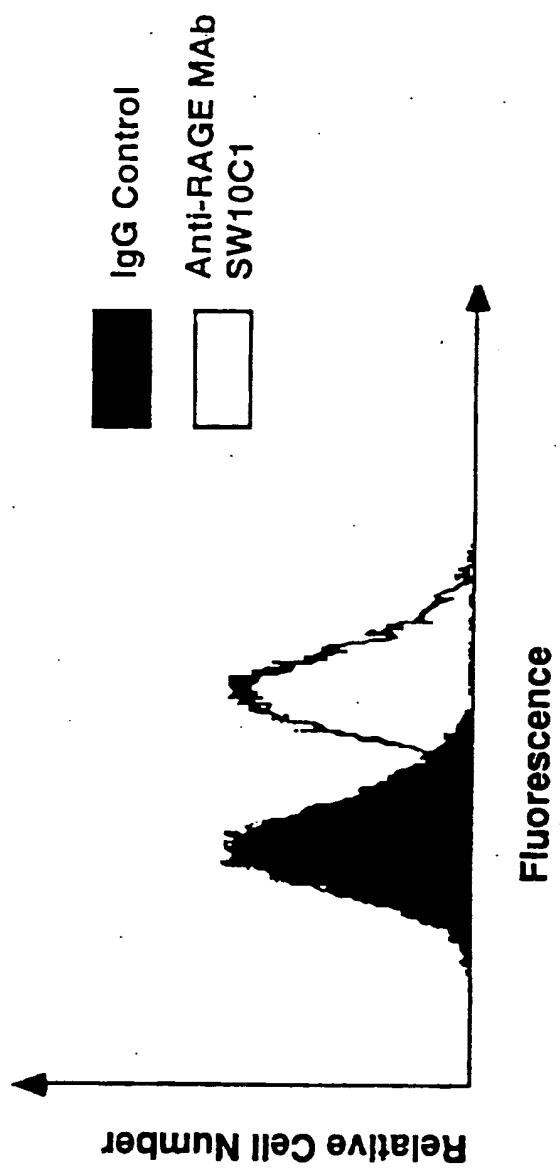


Figure 7

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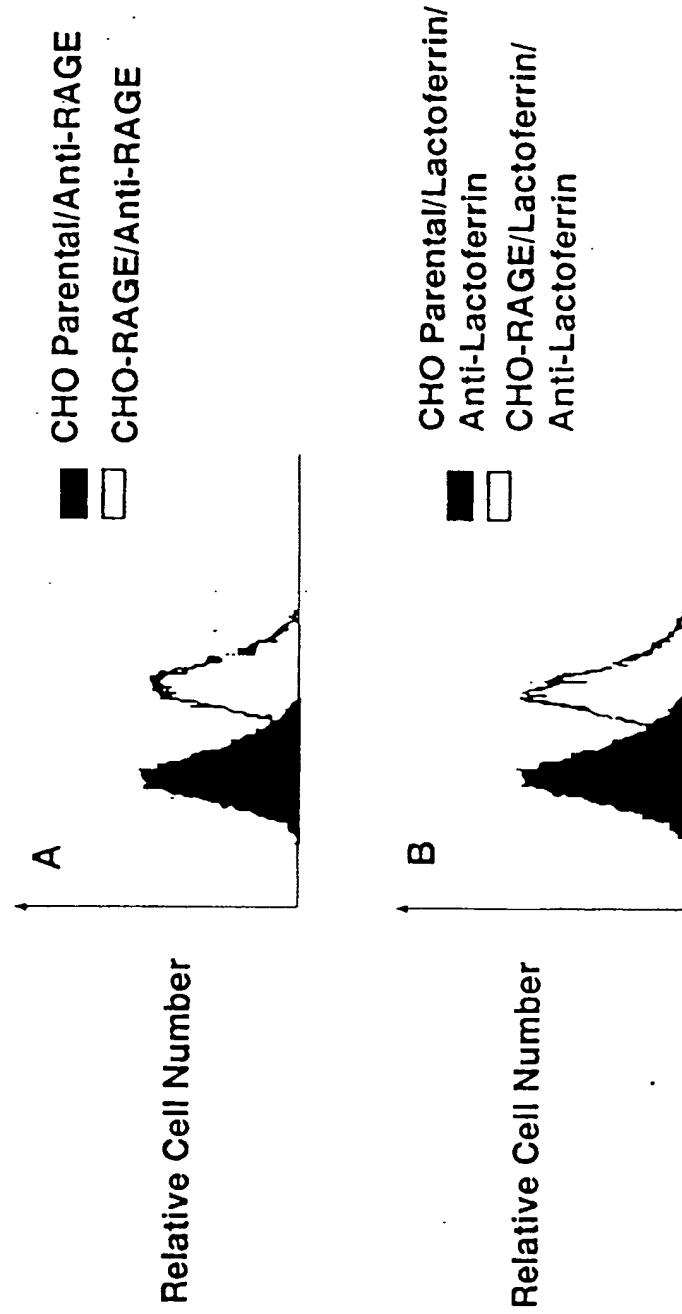


Figure 8

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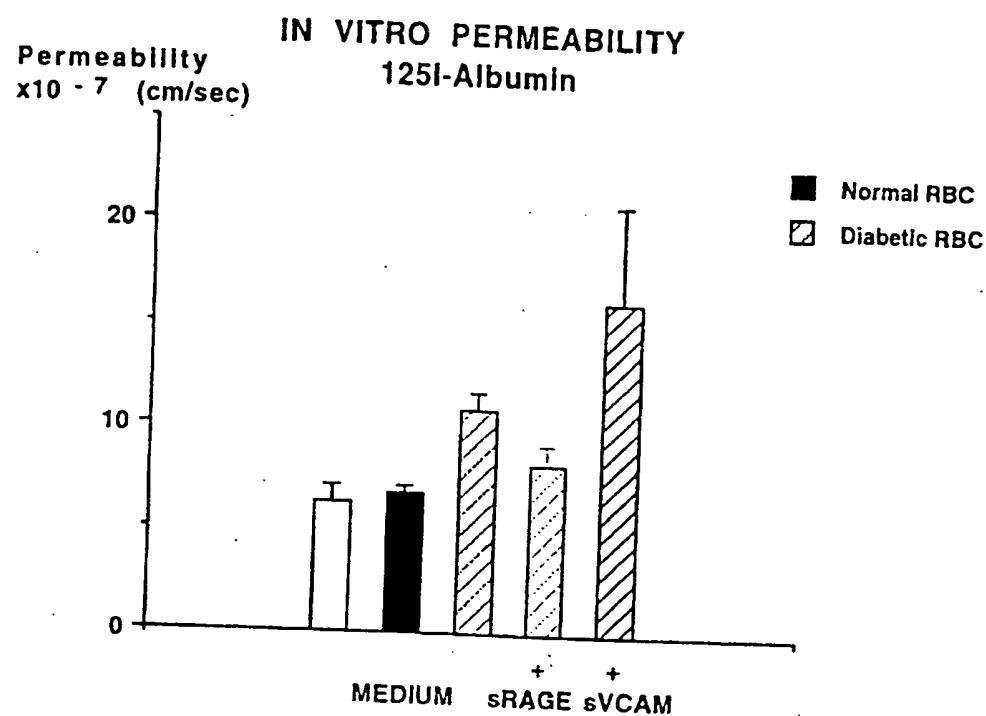


Figure 9A

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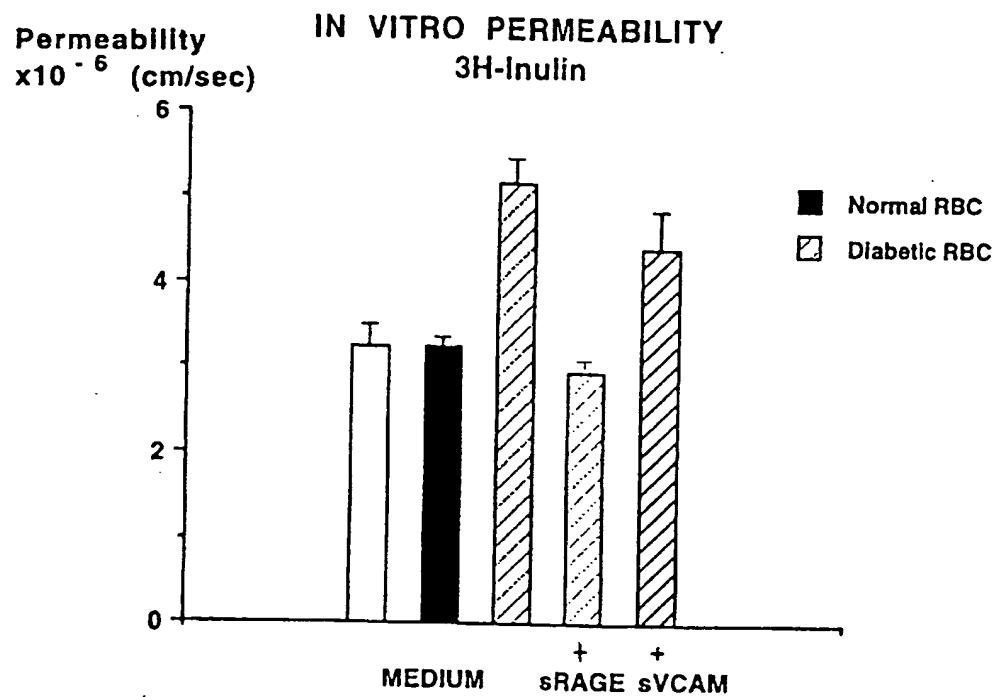


Figure 9B

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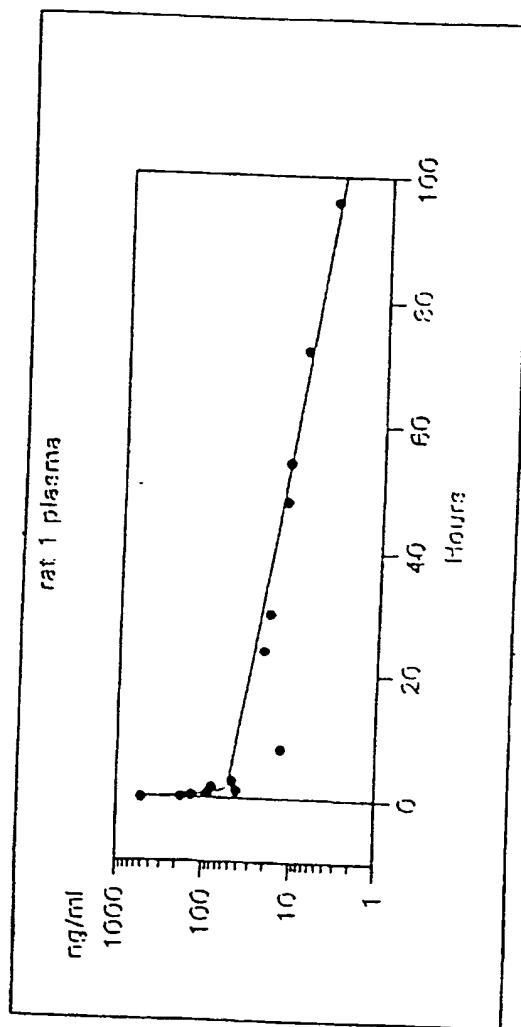


Figure 10

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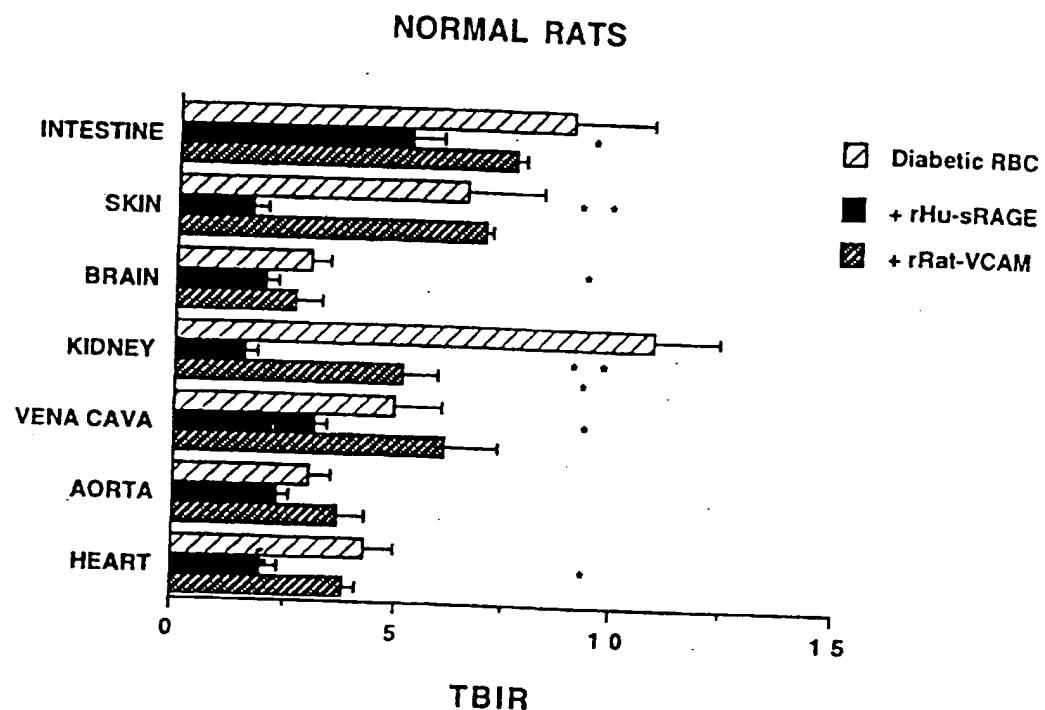


Figure 11A

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DIABETIC RATS

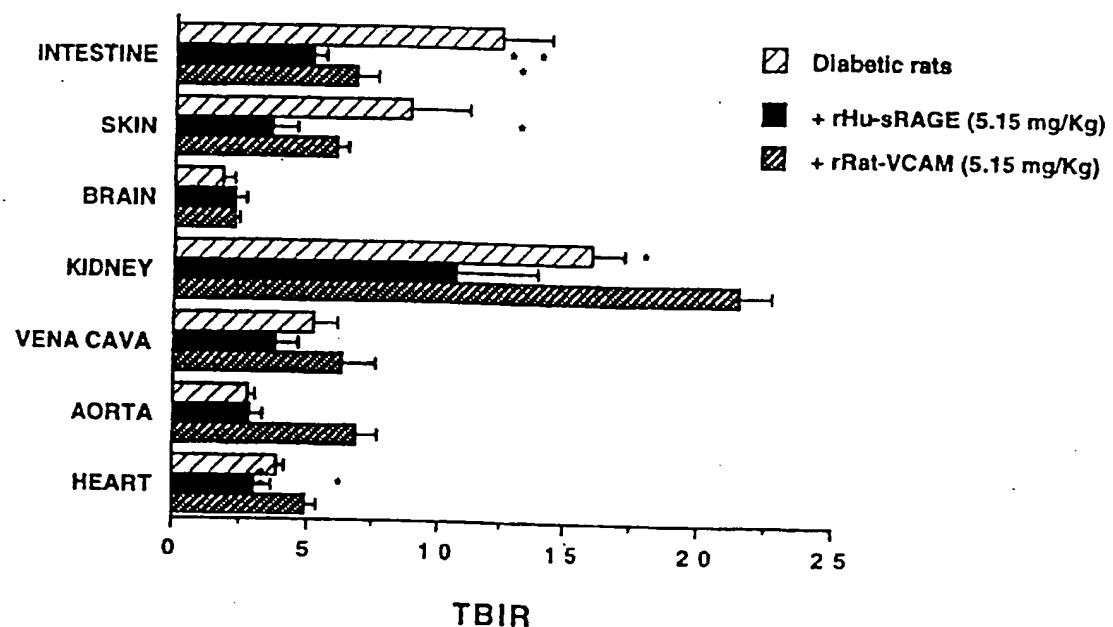


Figure 11B

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**BLOOD - TISSUE ALBUMIN TRANSPORT
TRACER UPTAKE METHOD**

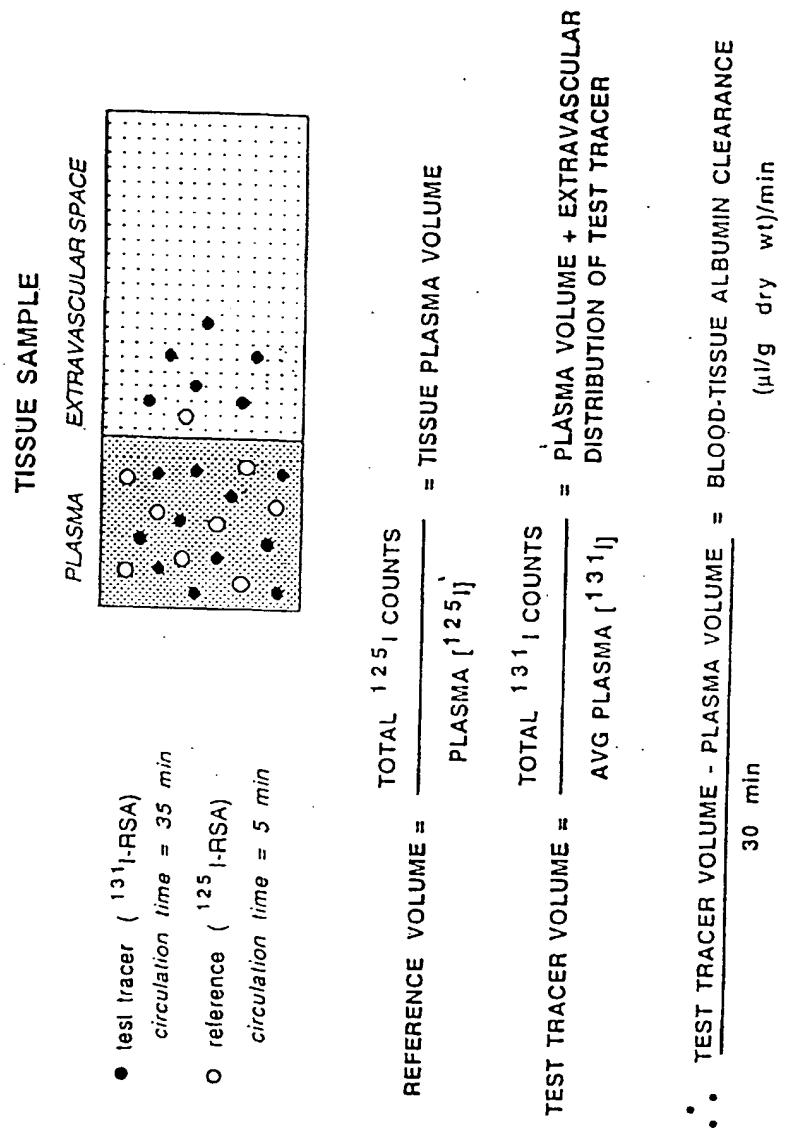


Figure 12

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ALBUMIN EXTRAVASATION AT 2-3 WKS POST-STZ

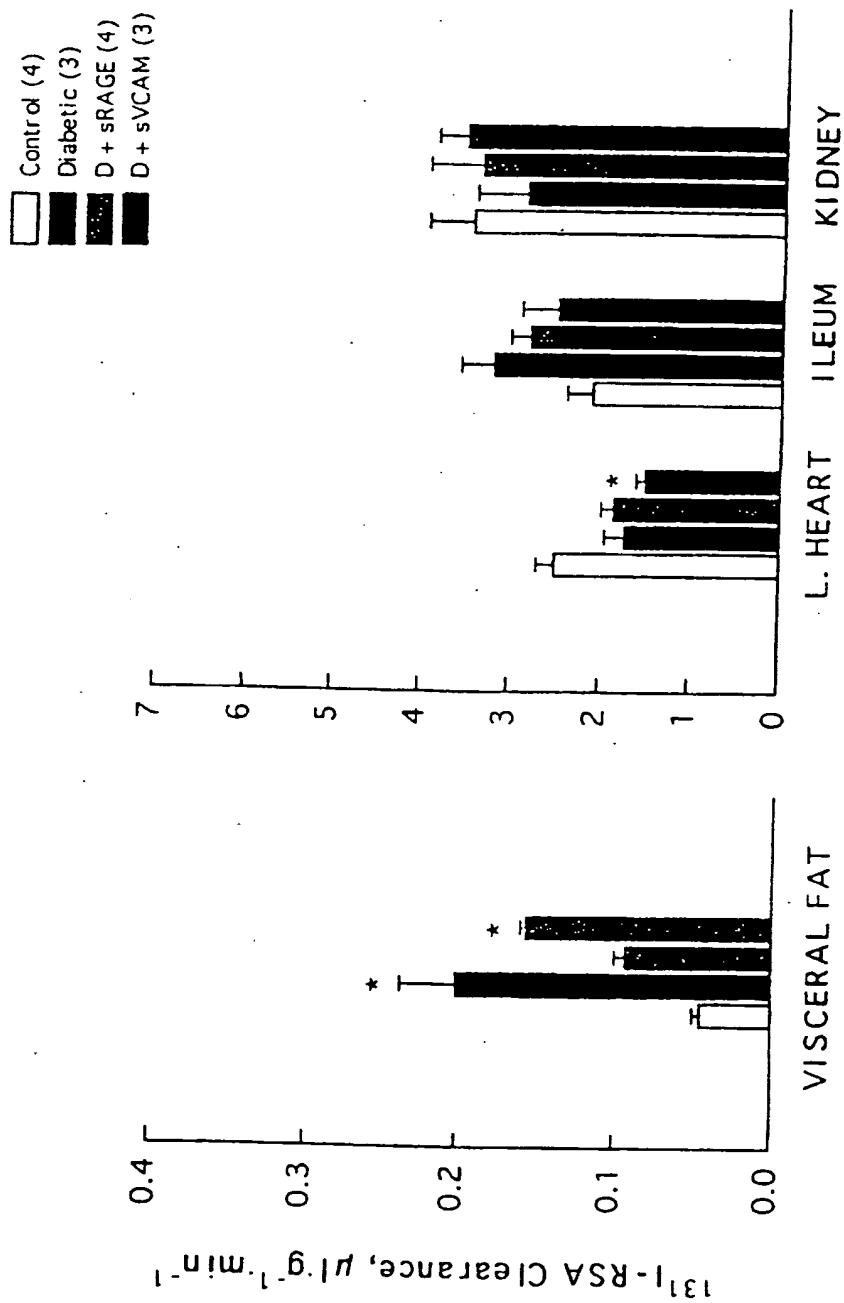


Figure 13A

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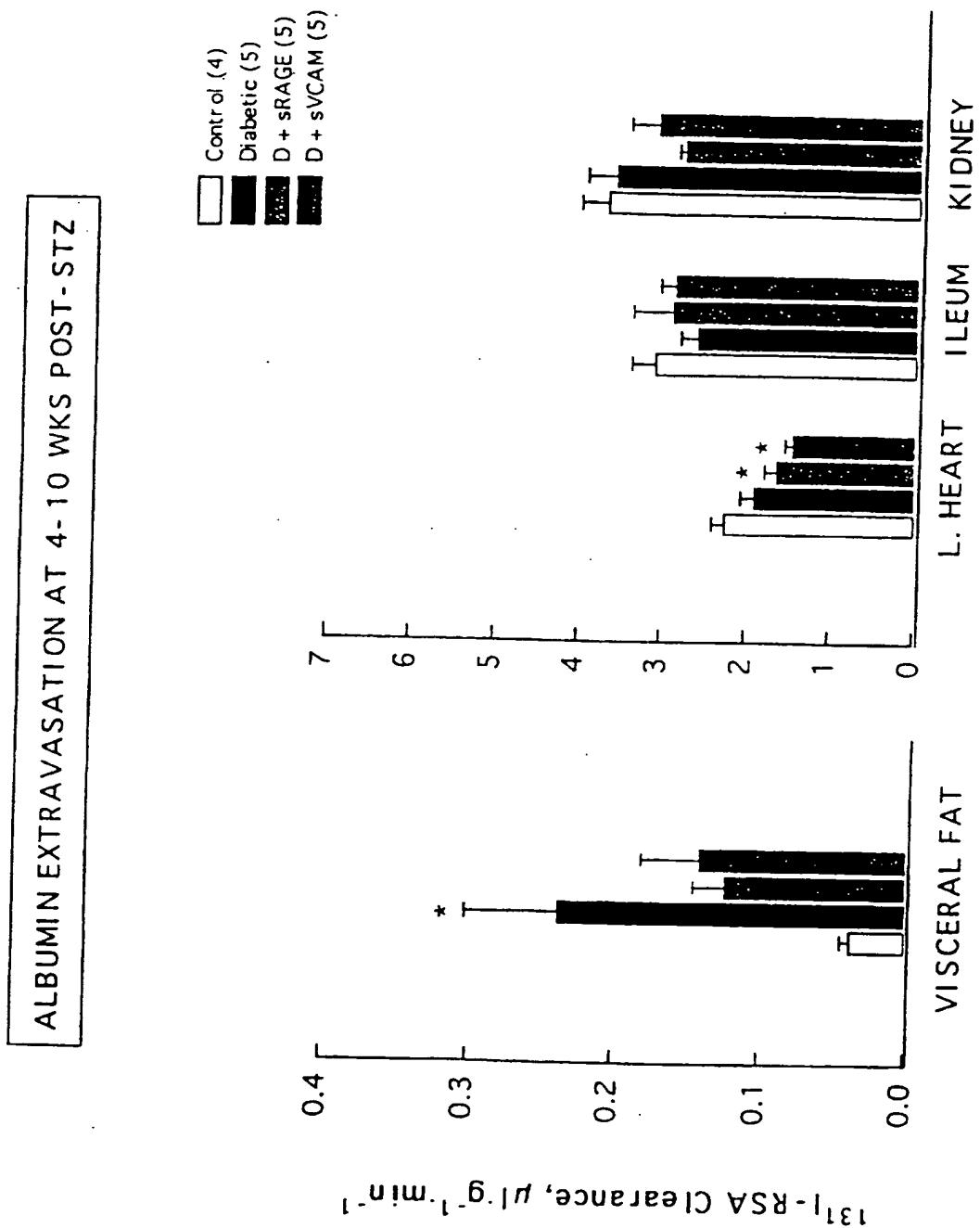


Figure 13B

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ALBUMIN EXTRAVASATION AT 11-20 WKS POST-STZ

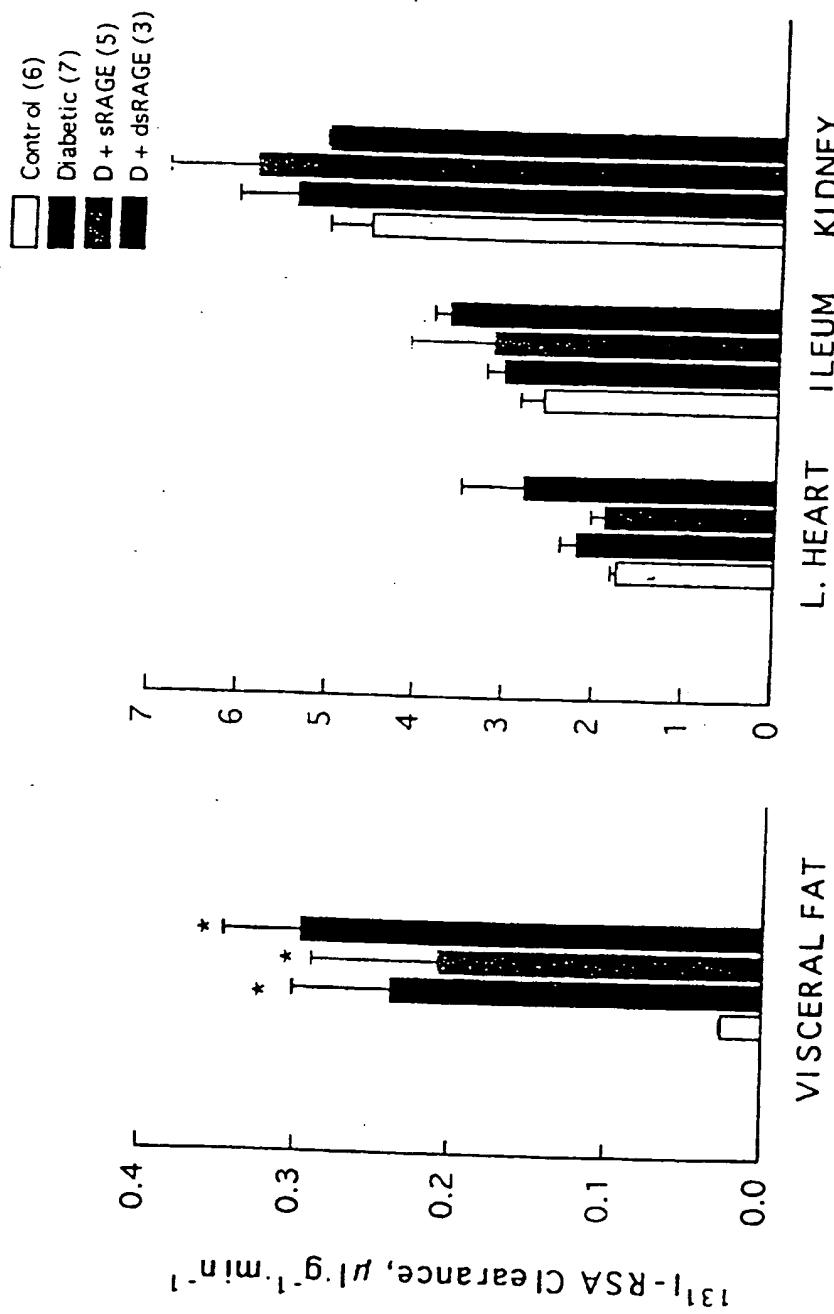


Figure 13C

EXTRAVASCULAR WATER AT 2-3 WKS POST-STZ

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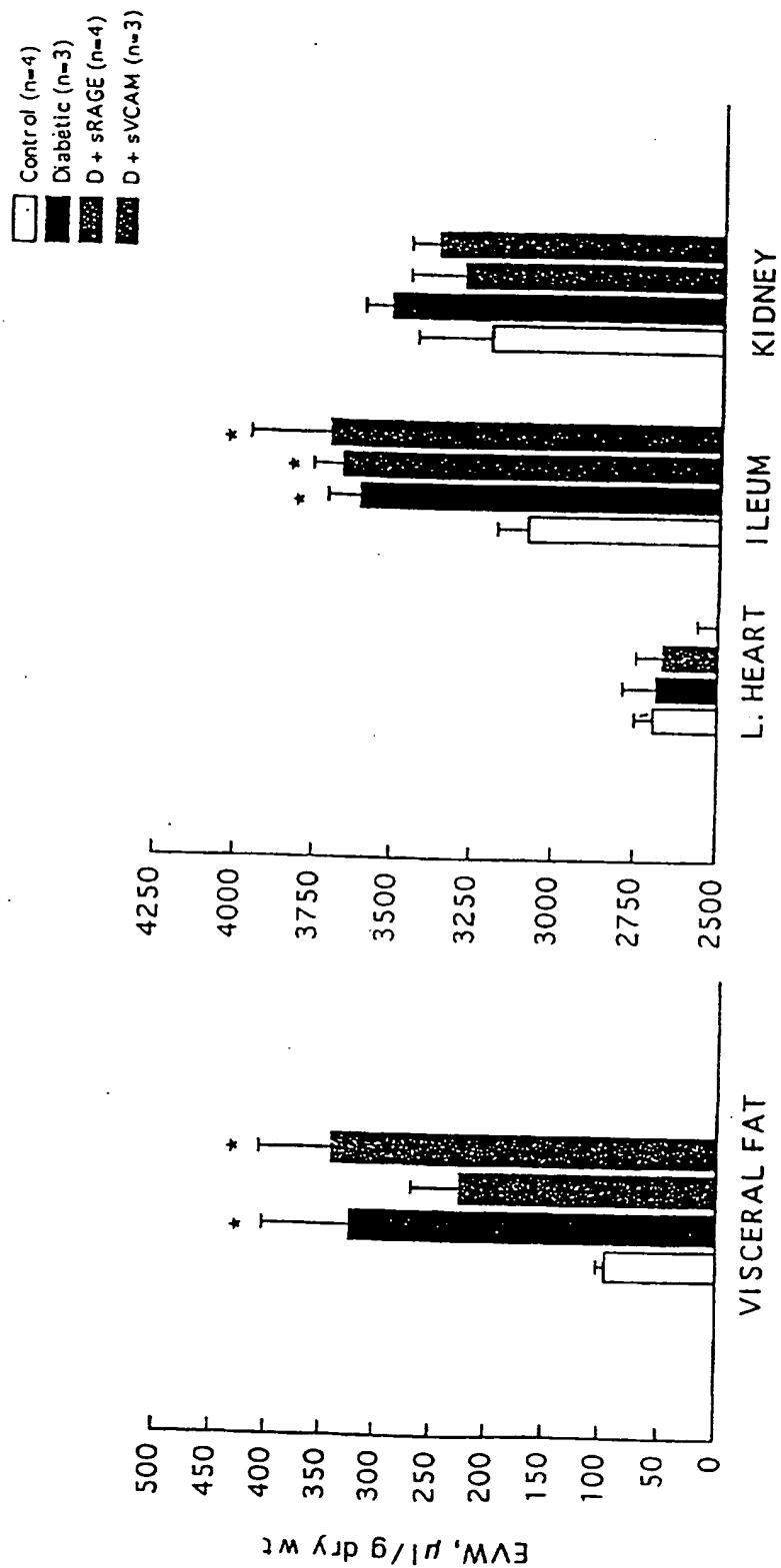


Figure 14A

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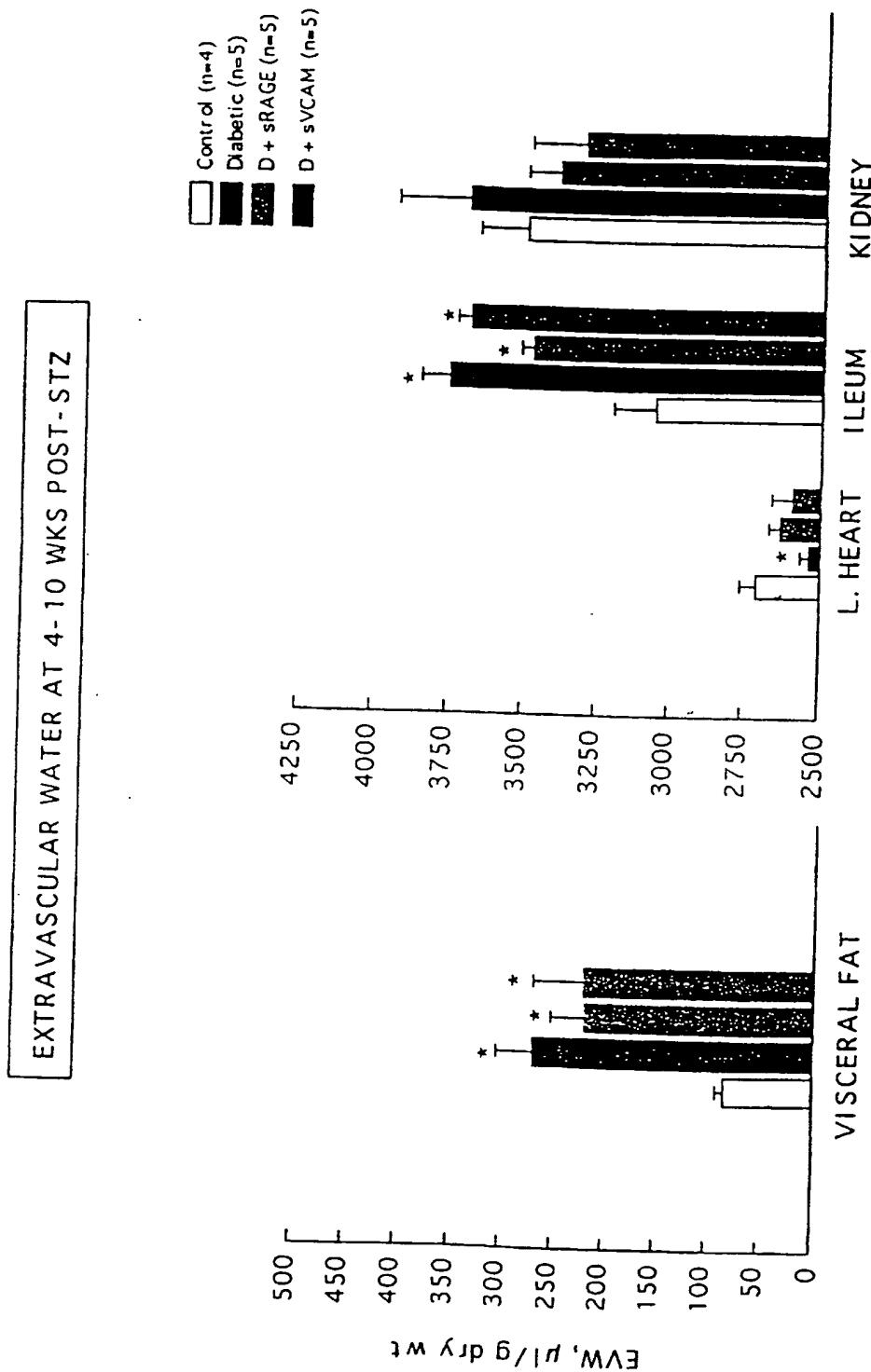


Figure 14B

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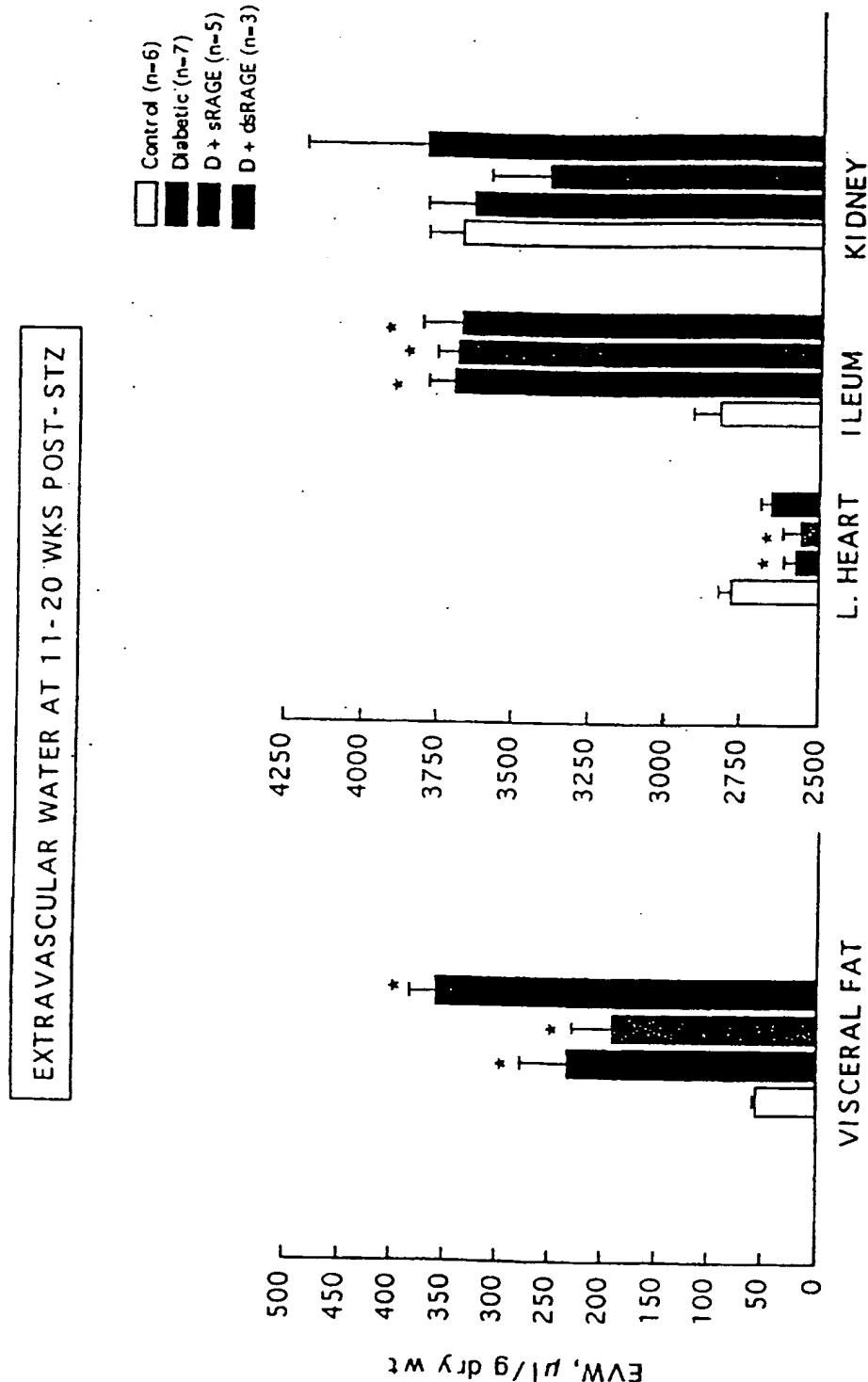


Figure 14C

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ADHERENCE OF DIABETIC RED CELLS TO VENULES IN SITU



1. Control post-capillary venule perfused with diabetic RBC

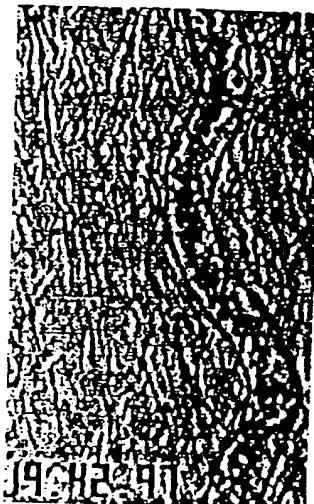


2. Same venule recannulated with Diabetic RBC + sRAGE (incubated 1 Hr)

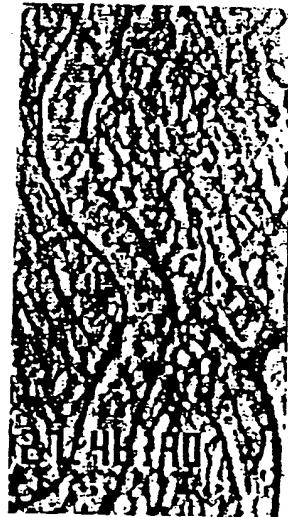
Figure 15A

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ADHERENCE OF DIABETIC RED CELLS TO VENULES IN SITU



1. Control post-capillary venule perfused with diabetic RBC + sRAGE



2. Same venule recannulated with Diabetic RBC - sRAGE

Figure 15B

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 97/01834

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 6 C12N15/13 C07K16/28 A61K39/395 G01N33/53

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 6 C07K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	THE JOURNAL OF BIOLOGICAL CHEMISTRY, vol. 267, no. 21, 25 July 1992, pages 14998-15004, XP002036214 NEEPEL ET AL: "CLONING AND EXPRESSION OF A CELL SURFACE RECEPTOR FOR ADVANCED GLYCOSYLATION END PRODUCTS OF PROTEINS" cited in the application see the whole document ---	1-4,6-27
X	THE JOURNAL OF BIOLOGICAL CHEMISTRY, vol. 269, no. 13, 1 April 1994, pages 9889-9897, XP002036215 YAN ET AL: "ENHANCED CELLULAR OXIDANT STRESS BY THE INTERACTION OF ADVANCED GLYCATION END PRODUCTS WITH THEIR RECEPTORS/BINDING PROTEINS" see the whole document ---	1-4,6-27
	-/-	

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- *'A' document defining the general state of the art which is not considered to be of particular relevance
- *'E' earlier document but published on or after the international filing date
- *'L' document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *'O' document referring to an oral disclosure, use, exhibition or other means
- *'P' document published prior to the international filing date but later than the priority date claimed

- *'T' later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *'X' document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *'Y' document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- *'&' document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
28 July 1997	07.08.97
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Authorized officer Sitch, W

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 97/01834

C(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, USA, vol. 91, August 1994, pages 7742-7746, XP002036216 WAUTIER ET AL: "ADVANCED GLYCATION END PRODUCTS (AGES) ON THE SURFACE OF DIABETIC ERYTHROCYTES BIND TO THE VESSEL WALL VIA A SPECIFIC RECEPTOR INDUCING OXIDANT STRESS IN THE VASCULATURE: A LINK BETWEEN SURFACE-ASSOCIATED AGES AND DIABETIC COMPLICATIONS" see the whole document ---	1-4,6-27
X	THE JOURNAL OF BIOLOGICAL CHEMISTRY, vol. 270, no. 43, 27 October 1995, pages 25752-25761, XP002036217 HORI ET AL: "THE RECEPTOR FOR ADVANCED GLYCATION END PRODUCTS (RAGE) IS A CELLULAR BINDING SITE FOR AMPHOTERIN. MEDIATION OF NEURITE OUTGROWTH AND CO-EXPRESSION OF RAGE AND AMPHOTERIN IN THE DEVELOPING NERVOUS SYSTEM" see the whole document ---	1-4,6-27
X	DATABASE CHEMICAL ABSTRACTS FILE SERVER STN KARLSRUHE ABSTRACT 122:233401, VLASSARA: "AGE-RECEPTORS AND IN VIVO BIOLOGICAL EFFECTS OF AGES" XP002036218 see abstract & SPEC.PUBL.-R.SOC.CHEM., vol. 151, 1994, pages 254-261, ---	1-4,6-27
X	DATABASE BIOSIS BIOSCIENCES INFORMATION SERVICE, PHILADELPHIA, PA, US ABSTRACT 94:62056, IMANI ET AL: "ADVANCED GLYCOSYLATION ENDPRODUCT-SPECIFIC RECEPTORS ON HUMAN AND RAT T-LYMPHOCYTES MEDIATE SYNTHESIS OF INTERFERON GAMMA: ROLE IN TISSUE REMODELLING" XP002036219 see abstract & JOURNAL OF EXPERIMENTAL MEDICINE, vol. 178, no. 6, 1993, pages 2165-2172, ---	1-4,6-27
		-/-

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 97/01834

C(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>DATABASE MEDLINE FILE SERVER STN KARLSRUHE ABSTRACT 97197240, HORI ET AL: "THE RECEPTOR FOR ADVANCED GLYCATION END-PRODUCTS HAS A CENTRAL ROLE IN MEDIATING THE EFFECTS OF ADVANCED GLYCATION END-PRODUCTS ON THE DEVELOPMENT OF VASCULAR DISEASE IN DIABETES MELLITUS" XP002036220 see abstract & NEPHROLOGY, DIALYSIS, TRANSPLANTATION, vol. 11, no. S5, 1996, pages 13-16,</p> <p>---</p>	1-4,6-27
X	<p>WO 93 04086 A (UNIV ROCKEFELLER) 4 March 1993 see page 3, line 33 - page 4, line 17 see page 8, line 12 - page 10, line 30 see page 46, line 17 - line 25 see page 52, line 1 - line 14</p> <p>-----</p>	1-4,6-27

INTERNATIONAL SEARCH REPORT

International application No.

PCT/EP 97/01834

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: **17-20**
because they relate to subject matter not required to be searched by this Authority, namely:
Remark: Although claim(s) 17-20
is(are) directed to a method of treatment of the human/animal
body, the search has been carried out and based on the alleged
effects of the compound/composition.
2. Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such
an extent that no meaningful International Search can be carried out, specifically:
3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this International Search Report covers all
searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment
of any additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this International Search Report
covers only those claims for which fees were paid, specifically claims Nos.:
4. No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is
restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
 No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 97/01834

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9304086 A	04-03-93	US 5585344 A US 5202424 A AU 2506792 A US 5316754 A	17-12-96 13-04-93 16-03-93 31-05-94